

**Appendices A, B, and C
for
TOTAL MAXIMUM DAILY LOAD (TMDL)
For
Metals, Pathogens and Turbidity
In the Hurricane Creek Watershed**

Appendix A: Hurricane Creek Modeling Report

**Appendix B: Hurricane Creek Watershed
Stream Bioassessment Report**

Appendix C: Baseline Sub Watershed Loads

Appendix D: Hurricane Creek Data Compilation

Available in a separate document entitled the Appendix D Hurricane Creek Data Excel Spreadsheet file
- Appendix D_ Hurricane Creek Data.xls



Appendix A

Model Application for TMDL Development
in the Hurricane Creek Watershed, Alabama

U.S. Environmental Protection Agency
Region 4

July 2001

Acknowledgments

Completion of this study depended upon the generous informational and data support from various groups. Special acknowledgment is made to the following people:

Larry Barwick	Alabama Surface Mining Commission
Glenda Dean	Alabama Department of Environmental Management
Jim Greenfield	United States Environmental Protection Agency, Region 4
Ed Hughes	Alabama Department of Environmental Management
Richard Hulcher	Alabama Surface Mining Commission
Vicki Hulcher	Alabama Department of Environmental Management
Randall Johnson	Alabama Surface Mining Commission
LeRoy Pearmen	USGS, Montgomery, Alabama
Lynn Sisk	Alabama Department of Environmental Management

1.0 Problem Understanding

Hurricane Creek is located entirely in Tuscaloosa County in north-central Alabama. The creek's approximate 116-square mile (74,329 acre) drainage area is represented by the Hurricane Creek watershed (Figure 1-1). The headwaters of the Hurricane Creek watershed form in Tuscaloosa County and flow in a westerly direction for approximately 31 miles until the stream's confluence with the Black Warrior River north of the city of Tuscaloosa. The major tributaries to the main stem are the North Fork Hurricane Creek, Little Hurricane Creek, Kepple Creek, and Cottondale Creek.

The watershed is located within the outcrop of the Pottsville Formation of Pennsylvanian age, which contains coal seams that have been extensively mined, producing surface water pollution and acid mine drainage problems (Geological Survey of Alabama 1999). The watershed is dominated by forested lands and disturbed areas due to coal-mining activities (USEPA 2000). Mined areas include active and inactive facilities as well as abandoned sites. Other land uses in the watershed include silviculture, and to a lesser extent, agriculture, industrial development, and residential development. The watershed's population is widely distributed throughout small towns and rural communities (Environmental Health Department, personal communication 2001); the largest towns in the watershed include Vance, Brookwood, and the outskirts of the city of Tuscaloosa.

Three waterbodies in the Hurricane Creek watershed have been included on Alabama's 1998 303(d) list due to metals, pathogen, and/or turbidity impairments (Table 1-1). These listed waterbodies include the entire main-stem of Hurricane Creek and two of its tributaries, North Fork Hurricane Creek and Little Hurricane Creek. The metals impairments, which include aluminum, arsenic, chromium, copper, and iron have been attributed to acid mine drainage (AMD). The turbidity impairments have been attributed to mining, silviculture, and residential development. The pathogen impairments are likely caused by nonpoint sources in the watershed such as cattle in the stream reaches and failing septic.

Table 1-1. 303(d)-listed waterbodies and corresponding impairments

Listed Segment ID	Stream Name	Length (mi)	Designated Use	Impairments	Sources
AL 03160112-120 01	Hurricane Creek	31.4	Fish & Wildlife	Aluminum, Iron, Pathogens, Turbidity	Surface mining-abandoned, Land development
AL 03160112-120 02	Little Hurricane Creek	10	Fish & Wildlife	Aluminum, Arsenic, Copper, Chromium, Iron, Pathogens	Surface mining-abandoned
AL 03160112-120 03	North Fork Hurricane Creek	6.4	Fish & Wildlife	Aluminum, Iron ^a	Surface mining-abandoned

^aNote that North Fork Hurricane Creek is not listed for iron on the Alabama 1998 303(d) list. However, very high concentrations of iron have been observed in the stream reach, therefore, iron impairments in North Fork Hurricane Creek will be considered in this study.

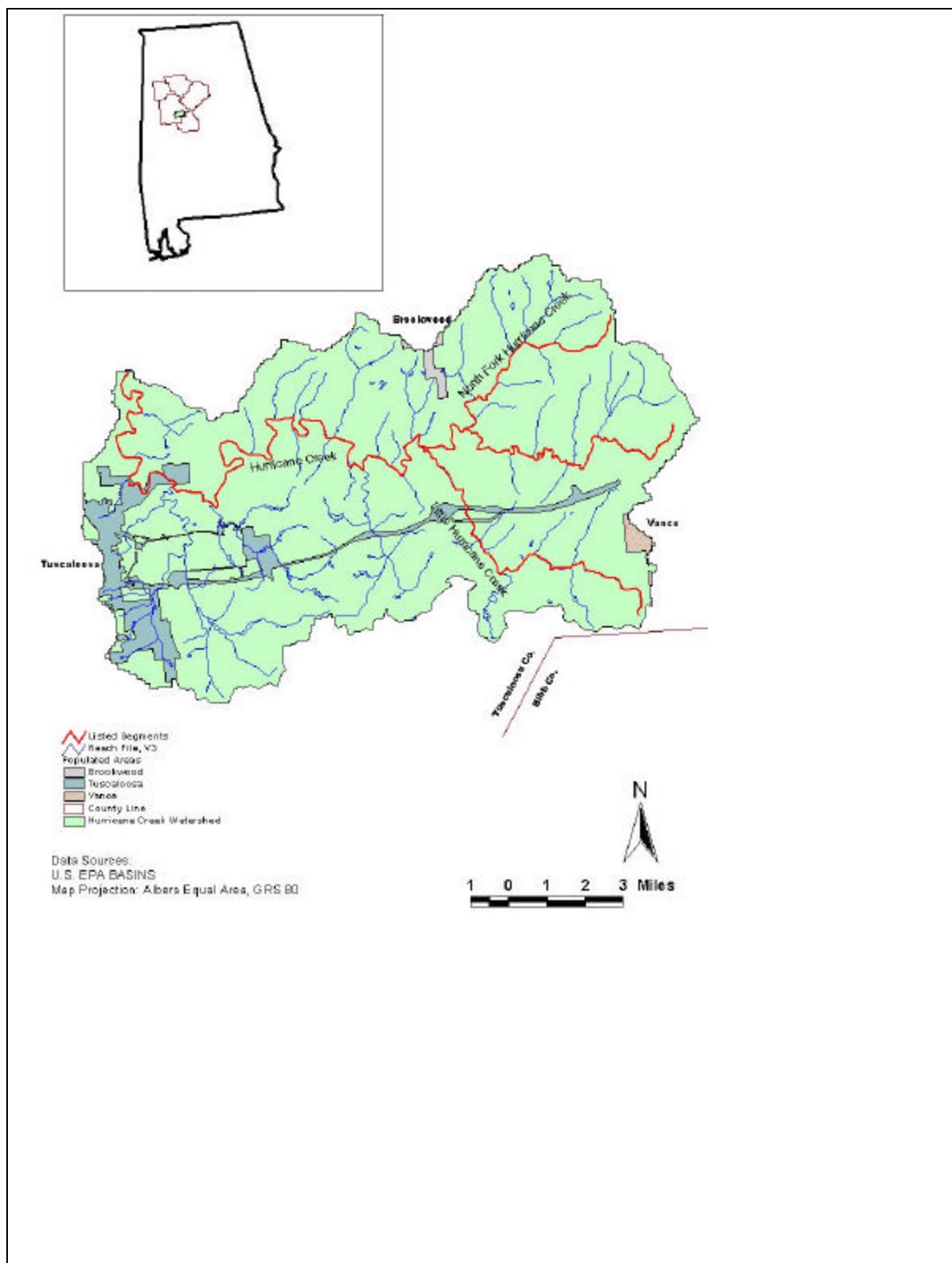


Figure 1-1. Location of the Hurricane Creek watershed

The EPA's *Water Quality Planning and Management Regulations* (40 CFR 130) require states to develop Total Maximum Daily Loads (TMDLs) for waters which are exceeding water quality standards. The objective of this study was to:

- \$ Confirm impairments by metals, pathogens, and turbidity in the Hurricane Creek watershed
- \$ Identify sources causing impairment
- \$ Develop a technical approach for developing TMDLs for the impaired waterbodies
- \$ Perform modeling to support TMDL development

This report presents background information and a description of the technical approach and modeling application of the Loading Simulation ProgramCC++ (LSPC) for the purpose of TMDL development for each of the three listed segments in the Hurricane Creek watershed.

2.0 Water Quality Standards

Alabama's water quality standards, Chapter 335-6-10 Water Quality Criteria, (ADEM 2000) have defined water quality criteria for surface waters as a numeric constituent concentration or a narrative statement representing a quality of water that supports one or more designated uses of the waterbody. All listed waterbodies in the Hurricane Creek watershed have been designated as having a fish and wildlife use. Metals and fecal coliform bacteria are given numeric criteria under the fish and wildlife use designation category (Table 2-1). The state of Alabama does not currently have numeric or narrative water quality criteria for aluminum or iron. Therefore, in the case of aluminum and iron, the federal water quality criteria are presented. Hurricane Creek is listed for pathogens, but water quality criteria for pathogens do not exist. Fecal coliform bacteria is used as a pathogen indicator. Fecal coliform will be referred to throughout the rest of this report to represent the pathogen impairment. Turbidity is also given numeric criteria under the fish and wildlife use designation category, but background levels of turbidity need to be determined to apply the criteria.

Table 2-1. Applicable federal and Alabama water quality criteria

Parameter	Use Designation		
	Fish and Wildlife		Human Health
	Acute ^a	Chronic ^b	Fish Consumption (mg/L)
Aluminum, Total (ig/L)	750	87	N/A
Arsenic, Trivalent (ig/L)	360	190	(HBW * RL) / (CPF * FCR * BCF)
Copper, Total (ig/L)	$e^{(0.9422[\ln(\text{hardness in mg/L as CaCo}_3)] - 1.464)}$	$e^{(0.8545[\ln(\text{hardness in mg/L as CaCo}_3)] - 1.465)}$	(HBW * RfD) / (FCR * BCF)
Chromium, Trivalent (ig/L)	$e^{(0.8190[\ln(\text{hardness in mg/L as CaCo}_3)] + 3.688)}$	$e^{(0.8190[\ln(\text{hardness in mg/L as CaCo}_3)] + 1.561)}$	N/A
Iron, Total (ug/L)	N/A	1000	N/A
Fecal Coliform ^c	Bacteria of the fecal coliform group shall not exceed a geometric mean of 1,000/100 mL; not to exceed 200/100 mL max geometric mean June-September; nor exceed a maximum of 2,000/100 mL in any sample. The geometric mean shall be calculated from no less than five samples collected at a given station over a 30-day period at intervals not less than 24 hours.		N/A
Turbidity ^c	There shall be no turbidity of other than natural origin that will cause substantial visible contrast with the natural appearance of waters or interfere with any beneficial uses which they serve. Furthermore, in no case shall turbidity exceed 50 NTU above background. Background will be interpreted as the natural condition of the receiving waters without the influence of man-made or man-induced causes. Turbidity caused by natural runoff will be included in establishing background levels.		N/A

Source: ADEM 2000; USEPA 1999

^a One hour average concentration not to be exceeded more than once every three years on the average,

^b Four-day average concentration not to be exceeded more than once every three years on the average,

^c Not to exceed

HBW = Human body weight, set at 70 kg

RL = risk level. Set at 1×10^{-5}

CPF = cancer potency factor, in (kg-day)/mg

FCR = fish consumption rate, set at 0.030 kg/day

BCF = bioconcentration factor, in 1/kg

RfD = reference dose, in mg/(kg-day)

There are approximately 11 existing water quality stations in the Hurricane Creek watershed. Examination of the data for the listed segments confirms that water quality criteria were exceeded in all stream reaches and for all listed pollutants except for the fecal coliform concentrations in Hurricane Creek and the iron concentrations in all three stream segments. Based on 32 fecal coliform observations on the main stem of Hurricane Creek from 1/23/92 through 8/28/96 at stations H-1, HCRT-1, HCRT-2, HCRT-3, and HCRT-4, the stream is not exceeding either the geometric mean or instantaneous criteria for fecal coliform. Based on iron observations at stations H-1, HCRT-1, HCRT-2, HCRT-3, HCRT-4, NFHT-1, LHCT-2A and LHCT-2B there is not enough iron data available to determine if the stream segments are exceeding the chronic iron criteria. However, based on some of the extremely high observed iron concentrations in the waterbodies, it is assumed that if 4-day average iron data were available they would be exceeding the criteria. See Appendix A.

3.0 Source Assessment

This section examines and identifies the potential sources of aluminum, arsenic, chromium, copper, iron, fecal coliform, and turbidity in the Hurricane Creek watershed. A wide range of data were used to identify potential sources and to characterize the relationship between point and nonpoint source discharges and in-stream response at monitoring stations.

3.1 Data Inventory

A wide range of data and information were used to characterize the watershed. The categories of data used include physiographic data that describe the physical conditions of the watershed and environmental monitoring data that identify potential pollutant sources and their contribution, and in-stream water quality monitoring data. Table 3-1 shows the various data types and data sources used in this model setup.

Table 3-1. Data inventory for the Hurricane Creek watershed

Data Category	Description	Data Source(s)
Watershed Physiographic Data	Land Use (MRLC) (mid 1990s)	USGS
	Abandoned Mining Coverage	Alabama Abandoned Mine Land Reclamation Division
	Stream Reach Coverage Reach File, Version 3	USEPAs BASINS
	Weather Information	National Climatic Data Center
Environmental Monitoring Data	NPDES Data	ADEM
	Permitted Mining Data	Alabama Surface Mining Commission
	Discharge Monitoring Report Data	Alabama Surface Mining Commission
	303(d) Listed Waters	ADEM
	Water Quality Monitoring Data for 11 Sampling Stations	EPA STORET and ADEM

3.2 Stream Flow Data

There are three USGS flow gages in the Hurricane Creek watershed. Flow data from two of these gages were used to support flow analysis for the watershed. Table 3-2 shows the two flow gaging stations used in this study and the corresponding period of record for each. These two stations were the only stations with sufficient data to characterize the stream flow in the watershed.

Table 3-2. Flow analysis for the Hurricane Creek watershed

Station	Stream Name	Drainage Area (square miles)	Start Date	End Date	Min (cfs)	Mean (cfs)	Max (cfs)
2463500	Hurricane Creek near Holt, Alabama	108	08/01/1952	09/30/1969	1.8	145.4	12,600
2463510	Hurricane Creek near Peterson, Alabama	112	10/01/1980	09/30/1981	7.2	94.6	3,800

3.3 Nonpoint Sources

In order to characterize the contributing nonpoint sources in the Hurricane Creek watershed, the nonpoint sources were classified into three major categories: metals sources, fecal coliform sources, and turbidity sources.

3.3.1 Metals Sources

Nonpoint sources represent contributions from diffuse, non-permitted sources. Based on the identification of a number of abandoned mining sites in the Hurricane Creek watershed, abandoned mine lands (AML) represent a critical nonpoint source. Abandoned mines can contribute significant amounts of acid mine drainage, which causes low pH and high metals concentrations in surface and subsurface water in areas where mining activities are or once were present. Because AML are present in the Hurricane Creek watershed in such abundance, nonpoint source contributions were grouped for assessment into two separate categories: AML and other nonpoint sources.

The metals impairments in the Hurricane Creek watershed are mainly caused by acid mine drainage (AMD) in the watershed. Acid mine drainage is in turn related to the geology of the watershed and its surrounding area. Background information on the geology of the watershed and the chemical processes affecting minerals associated with the geologic formations is essential in determining sources of pollutants to the impaired water bodies.

3.3.2 Hurricane Creek Geology

Geologically, the Hurricane Creek watershed is composed primarily of clays, sands and limestones of the Tuscaloosa Group. The rest of the watershed is composed of the Upper Pottsville Formation of the Pennsylvanian age. This level of the Pottsville Formation is composed of sandstones, shales (mudstones) and large discontinuous coal beds. The area of the Hurricane Creek watershed covered by the Pottsville Formation is part of the Warrior Coal Field (Figure 3-1). The coal beds in this area have been enriched over time by a diverse group of trace elements and metals including arsenic, copper, iron, and pyrite (USGS: MR-2357, 2000). The average concentration of arsenic in Alabama coal (72 ppm) is three times

higher than the national average (24 ppm). Furthermore, the Warrior Coal Field has some of the highest arsenic concentrations in Alabama with many observed concentrations above 200 ppm (USGS: MF-2333, 2000). Figure 3-2 presents a map of high Arsenic concentrations associated with coal bed locations. The geographical and stratigraphical distribution of arsenic, iron, pyrite, copper, and most other trace elements are generally found to be similar (i.e., they are found close together in the coal beds) (USGS: MF-2333, 2000).

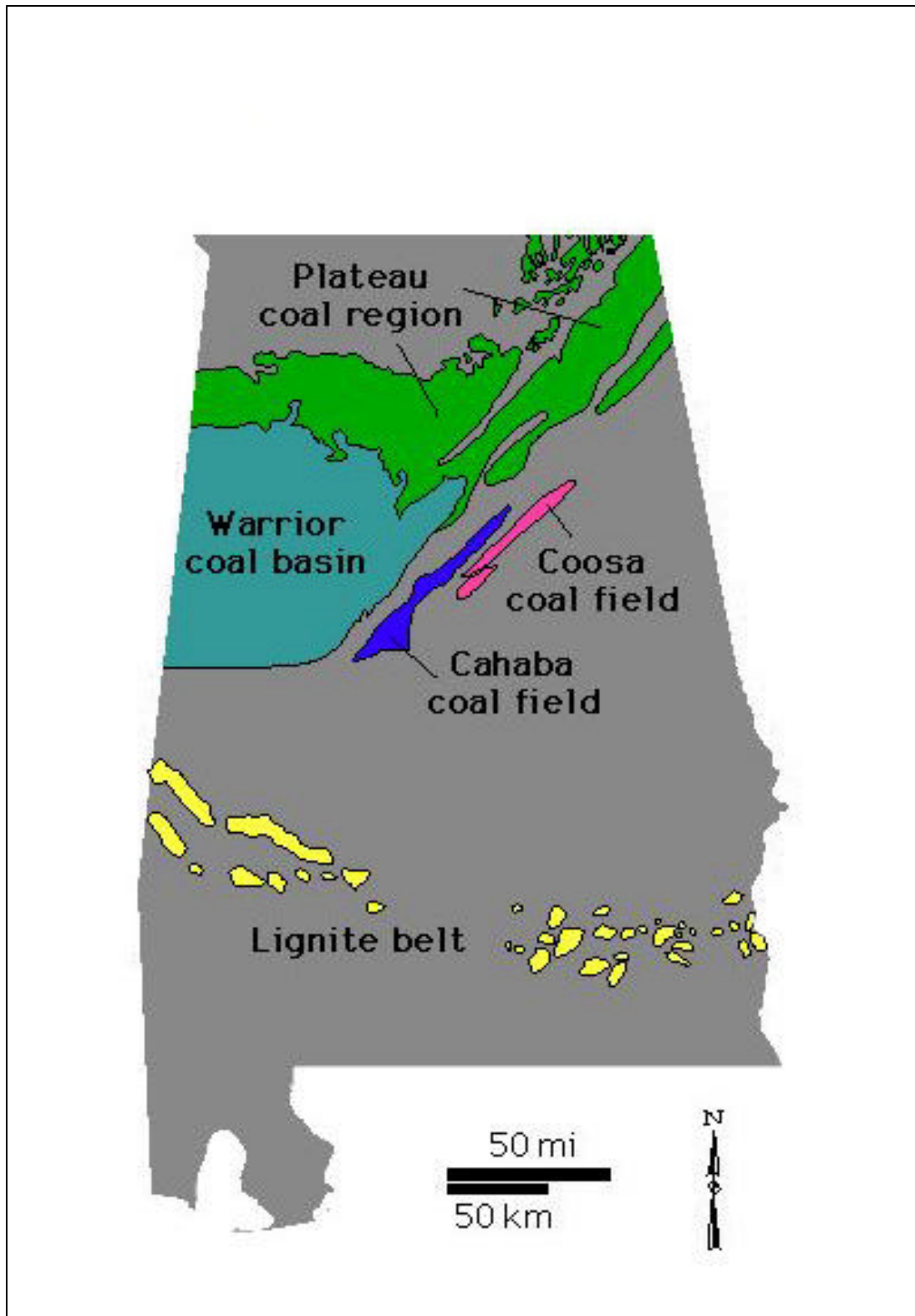


Figure 3-1. Map of Alabama showing the location of the Warrior Coal Field
(Source: Alabama Geological Survey, 2001)

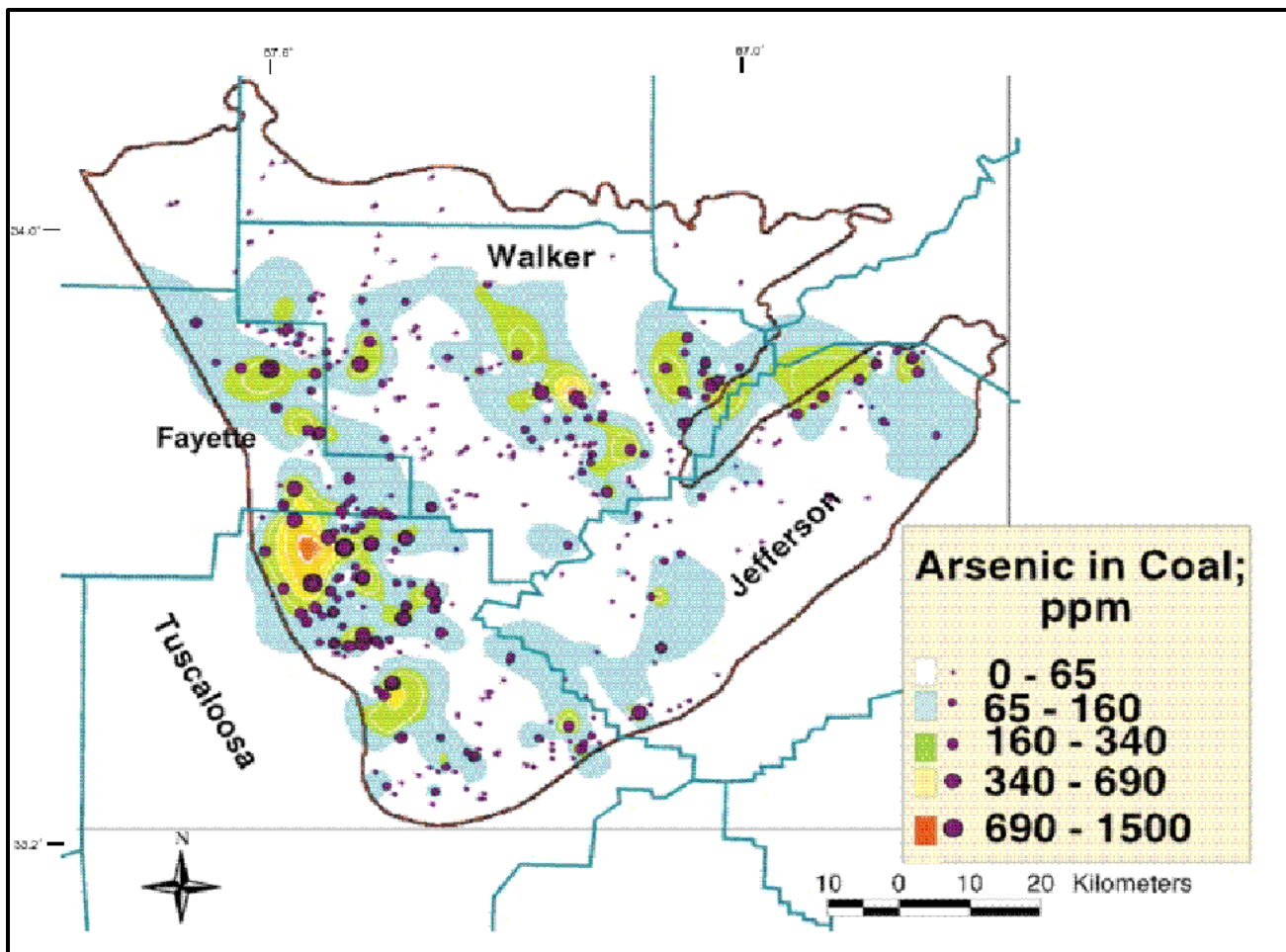


Figure 3-2. High arsenic concentrations in coal of the Pottsville Formation (Source: USGS MR-2333, 2000)

3.3.3 Acid Mine Drainage

AMD occurs when surface and subsurface water percolates through coal bearing minerals containing high concentrations of pyrite and marcasite, which are crystalline forms of iron sulfide (FeS_2). It is the chemical reactions of pyrite that generate acidity in water. A synopsis of these reactions is as follows: Exposure of pyrite to air and water causes the oxidation of pyrite. The sulfur component of pyrite is oxidized releasing dissolved ferrous (Fe^{2+}) ions and also hydrogen (H^+) ions. It is these H^+ ions that cause the acidity. The intermediate reaction with the dissolved Fe^{2+} ions generates a precipitate, ferric hydroxide [$\text{Fe}(\text{OH})_3$], and also releases more H^+ ions, thereby causing more acidity. Another reaction is one between the pyrite and generated ferric (Fe^{3+}) ions, in which more acidity (H^+) is released as well as Fe^{2+} ions, which then can enter the reaction cycle (Stumm and Morgan 1996). The acid components of pyrite mine waste are the potentially available Al^{3+} , iron (Fe^{2+} , Fe^{3+}), Mn^{2+} , and H^+ cations (Evangelou 1995). These acid components may also be referred to as exchangeable acidity. The level of acidity and the concentration of heavy metal pollutants in the mine drainage can be directly correlated to the amount of pyrite in the mining area (Colorado School of Mines 2001). In addition, sulfides of copper and arsenic will undergo similar geochemical reactions resulting in the contribution of toxic metal ions into mine waste water. Depending on geological factors, the metals found in mining waste may include iron, arsenic, copper, chromium, and aluminum as well as other metals (Environmental Mining Council of British Columbia 2001). The following

are brief descriptions of how the listed metals in addition to iron will react under oxidizing conditions and low pH due to the pyrite weathering process:

- Aluminum - Certain metals such as aluminum and iron are abundant in the environment but are not prevalent in most non-impaired streams because of their limited solubility at neutral pH. The acidity of mine drainage streams increases the solubility of metal oxide phases, and higher concentrations of these metals are observed. In acidic, metal enriched streams the ratio of hydrous metal oxide surface area to dissolved organic material is greater than in more typical streams (McKnight and Bencala 1990). One characteristic of acid waters is the presence of elevated concentrations of dissolved aluminum. This would be expected based on the basis of solubility of aluminum hydroxides and aluminosilicates (Drever 1997). The higher the concentration of complexing species present in groundwater, both inorganic and organic, the greater the solubility of minerals with components that form complexes. The divalent (Ca^{2+} , Mg^{2+} , SO_4^{2-} , CO_3^{2-}) and trivalent (Fe^{3+} , Al^{3+} , PO_4^{3-}) ions form fairly strong complexes with each other; therefore their presence in solution can increase solubility of minerals containing these components (Deutsch 1997).
- Arsenic - Metal oxyhydroxides such as ferric hydroxide have a very strong affinity for the arsenic(V) species and, like adsorption of other oxyanions (e.g., PO_4^{3-} and SeO_4^{2-}), this affinity increases with decreasing pH. The solubility of the various arsenic species depends on the presence of adsorbing surfaces, soluble cation type, concentration, and pH. Commonly, arsenic is present in geologic strata as arsenides (e.g., Cu_3As), or sulfides (e.g., AsS or arsenopyrite, FeAsS). Iron and iron-oxides appear to control the solubility of arsenic (Evangelou 1998). Under oxidizing conditions, arsenic is primarily affected by the adsorption of arsenic(V) onto metal oxyhydroxide surfaces (Deutsch 1997).
- Chromium - Under highly oxidizing conditions, the hexavalent form (chromate) is stable as an anion. Although it is not strongly adsorbed and is therefore mobile in the environment (Drever 1997), adsorption of chromium(III) increases with pH as the adsorbent surface sites become more negatively charged and attractive to cations. Specific adsorption of chromium(III) onto iron oxides occurs under oxidizing conditions. Under somewhat acidic conditions, it has been found that chromium(VI) is reduced by iron(II). In this case the reduction of chromium may be followed by the precipitation of low-solubility solid $(\text{Fe,Cr})(\text{OH})_3(\text{am})$, depending on the solution pH.
- Copper - Under oxidizing conditions, copper is soluble at low pH and is insoluble in carbonate/oxide/hydroxide forms at high pH (Drever 1997).

Abandoned Mine Lands (AML)

There have been both surface and deep mining activities in the Hurricane Creek watershed and consequently numerous AML sites that produce AMD flows (ASMC 2001) (Figure 3-3). Data regarding AML sites in the Hurricane Creek watershed were compiled from GIS coverages provided by ASMC and personal communication with Larry Barwick from the Alabama AML Reclamation Division. Information regarding the 12 abandoned mines in the Hurricane Creek watershed is presented in Table 3-3.

Table 3-3. Abandoned mine problem areas in the Hurricane Creek watershed

Problem Area Number	Area (acres)	Mining Features	Reclaimed / Unreclaimed	Problem Area Name
AL000012SGA	43	Spoil area	U	KLONDIKE EAST
AL000013CIA/SGA/RMA	20	Spoil area	R	FLEETWOOD
AL000026RMA/SGA	153	Spoil Area	R	KLONDIKE, WEST
AL000029SGA	23	Spoil Area	R	HOWTON, SOUTH
AL000043SGA	240	Spoil Area	U	NORTH ALABAMA JUNCTION E
AL000172SGA	unknown	3 portals	R	CEDAR COVE
AL000172SGA	unknown	14 mine openings	U	CEDAR COVE
AL000476SGA	unknown	46 mine openings	R	TUSCALOOSA, EAST
AL000607SGA	16	Spoil area	R	DUDLEY
AL000619SGA	20	Spoil area	U	CEDAR COVE, WEST
AL000710SGA	184	Spoil area		HANNA MILL CREEK
AL000720RUA/SGA	40	Spoil area	R/U	FLEETWOOD, NORTH
AL000841CIA	10	Spoil area	R	ALCO

Other Nonpoint Sources

The predominant land uses in the Hurricane Creek watershed were identified based on the USGS's Multi-Resolution Land Characterization (MRLC) land use data (representative of the mid-1990s). According to the MRLC data, the major land uses in the watershed are forest land, which constitutes approximately 67 percent of the watershed area. In addition to forest land, other land uses which may contribute nonpoint source metals loads to the receiving streams include barren and urban land. The land use distribution for the Hurricane Creek watershed is presented in Figure 3-2. Background concentrations of metals are naturally high in the watershed. It is likely that higher metals loadings are contributed by barren, harvested, strip mined, or agricultural land than forest due to the fact that runoff and erosion potential is greater for land uses without adequate vegetation cover.

3.3.4 Fecal Coliform Sources

The Alabama water quality criteria for pathogens are based on fecal coliform bacteria as an indicator organism. Fecal coliform yields a general assessment of water quality for the designated use. High

concentrations of fecal coliform *might* suggest that pathogens are present in the water body. Comparison of fecal coliform at water quality station H-1 to simulated flow data (observed flow data was not available for the particular time period) at

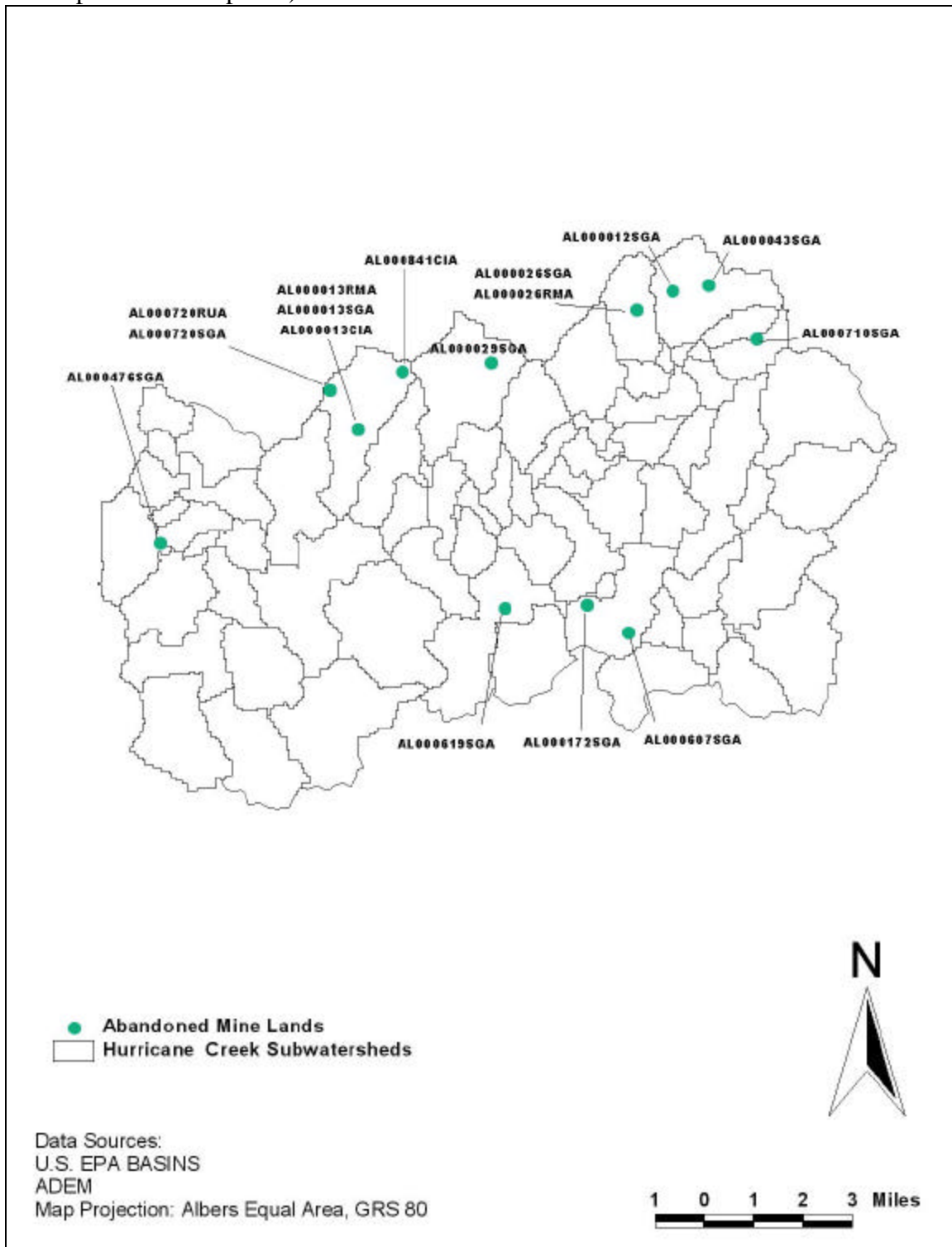


Figure 3-3. AML locations in the Hurricane Creek watershed

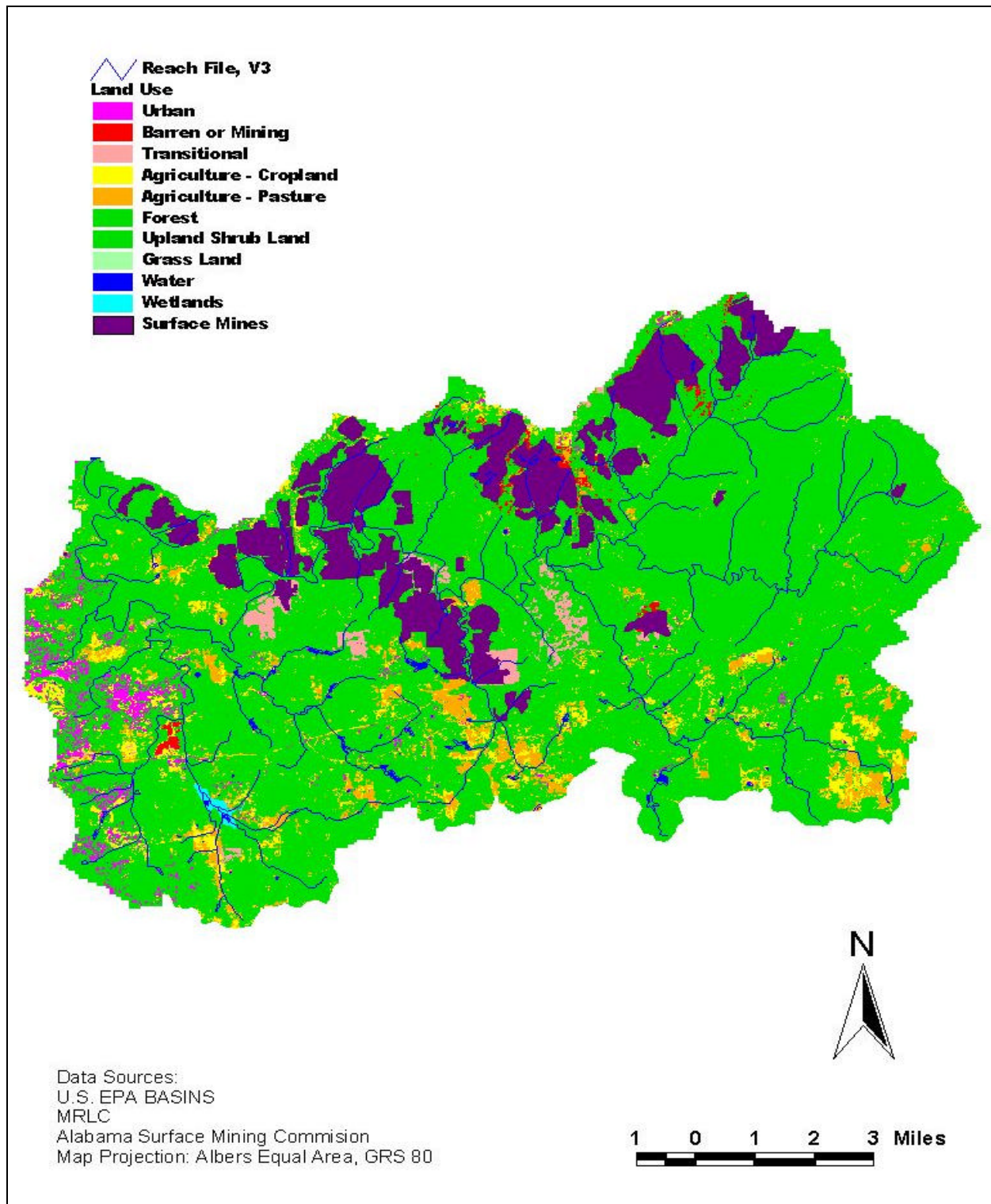


Figure 3-4. Land uses in the Hurricane Creek watershed

the corresponding time shows that fecal coliform concentrations are present in relatively high concentrations at both high and low flow conditions, indicating that there may be a number of sources contributing to fecal

coliform impairment in the watershed. Nonpoint sources of fecal coliform bacteria are typically separated into urban and rural components. Urban settings are typically characterized by large areas of paved impervious surfaces. Important sources of fecal coliform loads in urban areas are storm runoff from impervious and pervious areas, failing septic tanks, illicit discharges, and leaking sanitary sewer systems. In rural settings, the amount of impervious area is usually much lower, resulting in greater infiltration of precipitation and less runoff. Sources of fecal coliform in rural areas may include runoff from fields receiving land application of animal wastes, runoff from concentrated animal operations and grazing land, contributions from wildlife, cattle in the stream, and failing septic tanks.

The Hurricane Creek watershed was evaluated to identify and quantify sources of bacteria within the watersheds of the listed segments. The identified nonpoint sources of fecal coliform bacteria within the watersheds of the listed segments include:

- Runoff from pastureland with grazing livestock
- Runoff from cropland
- Failing septic systems
- Wildlife contributions
- Cattle in streams
- Runoff from residential and urban areas

Grazing Livestock

Grazing cattle and other agricultural animals deposit manure and, therefore, fecal coliform on the land surface, where it is available for washoff and delivery to receiving water bodies. Although specific information regarding agricultural management practices and activities are not readily available, ADEM keeps a database of agricultural and land use information provided by the various Soil and Water Conservation Districts within the state. The information in the database is based on the 1997 Agricultural Census. Data from ADEM's agricultural database provided estimates of livestock in the Hurricane Creek watershed. Total pastureland within the watershed was provided by the MRLC land use coverage. The livestock counts and pasture areas were used to determine livestock densities (e.g., number of cows per acres of pastureland) for the watershed, assuming livestock are evenly distributed over pasture area.

The area of pastureland in each subwatershed was determined using GIS data layers. The pasture area of the subwatershed and the livestock density for the watershed were used to calculate the livestock counts within each subwatershed.

The total livestock counts for the Hurricane Creek watershed are presented in Table 3-4.

Table 3-4. Livestock counts in the Hurricane Creek watershed

Cattle	Hogs	Chickens
580	36	186,480

Source: ADEM Agricultural Database

Failing Septic Systems

Septic systems are common in unincorporated portions of the watershed and may be direct or indirect sources of bacterial pollution via ground and surface waters. A high percentage of the citizens in the Hurricane Creek watershed rely on septic systems for wastewater treatment (Tuscaloosa Environmental Health Department 2001). The information in the aforementioned ADEM database contains numbers and failure rates for the Hurricane Creek watershed. Onsite septic systems have the potential to deliver fecal coliform bacteria loads to surface waters due to system failure and malfunction. To evaluate this loading, it is necessary to evaluate where septic tanks are located and what proportion of these are malfunctioning.

The number of septic systems in the Hurricane Creek watershed were provided by ADEM, but the spatial distribution of septic tanks is not known. For modeling purposes, spatial distribution was assumed to be partially correlated with areas of low-intensity residential land. Fifty percent of the septic systems in the watershed were distributed based on the location of low-intensity residential land use areas and the remaining 50 percent were distributed evenly throughout the watershed (based on density) to account for individual homes and businesses not represented in the low-intensity residential land use coverage.

The septic systems assigned based on low-intensity residential areas were assigned by weighting the amount of low-intensity residential land found within each subwatershed. The low-intensity residential land use areas near the city of Tuscaloosa were weighted less than other residential areas in the watershed because it was assumed that a high proportion of these neighborhoods are served by sewerage systems and, therefore, do not use septic tanks.

After estimating the number of septic systems per watershed, the number of failing systems per subwatershed were determined in order to calculate bacteria loading. ADEM (2001) estimates the septic failure rate in the Hurricane Creek watershed to be approximately 10 percent. It was assumed that failing systems are distributed evenly throughout the watershed area.

Wildlife

Wildlife is another potential source of fecal coliform loading to receiving water bodies. For modeling purposes, the deer population is assumed to represent the wildlife contribution, since population data for other wildlife species in the watershed was not provided. It is also assumed that deer habitat within the watershed includes forest, cropland, pasture, and wetland land uses. Typical estimates for distributions of deer within the region were provided by the Alabama Department of Conservation Division of Wildlife and Freshwater Fisheries (2000). Two different densities (deer per square mile) were available for the watershed, representing different management areas. The provided densities were applied to deer habitat areas within the watershed to estimate population counts by subwatershed. An average density (15 deer/mi²) was applied to the forest, cropland, pasture, and wetland areas.

Cattle in the Stream

ADEM's Agricultural Database provided information stating that livestock commonly have access to streams. When cattle are not denied access to stream reaches, they represent a major potential source of direct fecal coliform loading to the stream. To account for the potential influence of cattle loads deposited directly in stream reaches within the watersheds, fecal coliform loads from cattle in streams were calculated

and characterized as a direct source of loading to the stream segments. To determine the number of cows in the stream at any time, it was assumed that 10 percent of the cows in the watershed have access to streams; that 7 percent of those cows are in or around the stream at any given time; and that 5 percent of those cows in the stream are actually depositing manure in the stream reach at any given time.

3.3.5 Turbidity Sources

Thirty five percent of the 241 turbidity observations at water quality station H-1 from 1/13/76 to 12/9/96 were exceeding the water quality criteria based on a background turbidity concentration of 13 NTU that was used for listing on the 1998 303(d) list. See Appendix A. Turbidity is measured in NTUs, not a concentration, so another parameter that is measured as a concentration must be used to represent turbidity loadings in the watershed. Total suspended solids (TSS) is used as the turbidity indicator in this project based on the assumption that the main sources of turbidity in the watershed are sediment loadings from the large amounts of disturbed mining land as well as urban/residential land, paved and unpaved roads, and silviculture. Turbidity tends to be highest in the spring and appears to be correlated with high runoff and erosion from disturbed land and iron precipitates formed by AMD (See Section 3.4.3). Mining, silviculture, and urban/residential land have been identified as the most likely contributors of sediment to the Hurricane Creek watershed based on water quality data analysis and literature on the Hurricane Creek watershed. The urbanization and paving of large areas of the watershed can result in dramatic increases in stormwater runoff, which leads to periodic high flows that erode stream banks and contribute increased amounts of silt and associated metals to the shallow creek bottom. These nonpoint sources are extremely difficult to pinpoint, measure, and control, but they are a possible cause of degradation of water quality in the Hurricane Creek basin.

Agricultural Land

Agricultural runoff from cropland and pasture can often contribute increased pollutant loads to a water body when poor farm management practices allow soils or animal waste to be washed into the stream, increasing in-stream sediment levels.

Based on the MRLC land use coverage, the cropland percentage in the impaired watersheds ranges from 0 to 14.5 percent. When hay/pasture and cropland are combined, the percentage of agricultural land ranges from 0 to 32.7 percent.

Silviculture

Silviculture, especially forest harvesting, can be an important nonpoint source of sediment to water bodies. The USDA's Forest Service FIA Database Retrieval System provided information on silvicultural practices in the Hurricane Creek watershed. Forest land in the basin includes all land with at least 10 percent stock forest trees of any size, or formerly having such tree cover, and not currently developed for non-forest use. Timberland represents the portion of forest land that is producing, or is capable of producing, crops of industrial wood and is not withdrawn from utilization. All forested acres in the Hurricane Creek watershed are considered to be timberland. The average net annual growth is the average change in volume of either growing-stock or saw timber in one year for the time period between two successive forest inventories minus the average annual volume lost to mortality from natural causes. The average annual removal rate is the average volume of either growing-stock or saw timber removed in one year by harvesting, cultural

operations, land clearing, or changes in land use for the time period between two successive forest inventories. Table 3-5 presents the annual harvested growing stock in Tuscaloosa County, Alabama.

Table 3-5. Annual harvested growing stock for Tuscaloosa County, Alabama

Area	All Species (acres)	All Softwood (Evergreen) (acres)	All Hardwood (Deciduous) (acres)
Tuscaloosa County	37,359	27,409	9,950
Hurricane Creek	3,190	2,340	850

Harvested hardwood and softwood acres for each subwatershed in the Hurricane Creek basin were based on the percentage of Tuscaloosa County within each subwatershed. The harvested areas for both softwoods and hardwoods were subtracted from the corresponding land use categories in the MRLC land use coverage.

Urban/Residential Areas

Urban and residential areas are represented in the MRLC land use coverage by the “urban” land use (Figure 3-4). Sediment from nonpoint sources may be carried into streams through surface runoff and through erosion from unpaved areas and construction sites. Paved and unpaved roads are potential sources of sediment in populated areas and in some rural areas where logging occurs. The area of paved roads in the watershed was determined by measuring the length of paved roads in the provided paved road coverage and multiplying by an estimated average width of 25 feet. Unpaved roads have been indicated by ADEM to be a potential source of TSS to the watershed, but no information on unpaved road locations was provided. Tuscaloosa County is currently working on a GIS coverage of unpaved roads, but it will not be available until a later date. The area of unpaved roads was determined by assuming that the unpaved roads are approximately 1/3 of the area of the paved roads. The width assumed for unpaved roads in the watershed was 10 feet.

3.4 Point Sources

In order to characterize the contributing point sources in the Hurricane Creek watershed, the point sources were classified into two major categories: permitted non-mining point sources and permitted mining point sources.

3.4.1 Permitted Non-mining Point Sources

Data regarding non-mining point sources were retrieved from ADEM. The non-mining point sources in the Hurricane Creek watershed typically do not discharge significant amounts of metals or fecal coliform and hence do not have permit limits for these pollutants. There are three permitted municipal facilities in the Hurricane Creek watershed permitted to discharge total suspended solids (TSS). These three sources are included as potential sources of turbidity to the watershed. These three municipal point sources do not have

permit limits for fecal coliform, but for the purpose of this study, it was assumed that they are discharging fecal coliform at the Alabama NPDES criteria for fecal coliform of 200 counts/100 mL.

Table 3-6 presents the facility information.

Table 3-6. Permitted non-mining point sources in the Hurricane Creek watershed

NPDES Number	Facility Name	Status	Receiving Water body	Permit Limit (mg/L)	Design Flow (cfs)
AL0050652	Brookwood High School	Active	Tributary to Hurricane Creek	90	0.026
AL0050695	Holt Elementary School	Active	Unnamed Tributary to Hurricane Creek	90	0.03
AL0057517	Brookwood Shell Truck Stop	Active	Unnamed Tributary to Hurricane Creek	90	0.01

3.4.2 Permitted Mining Point Sources

Mining related point source discharges, from both deep, surface, and other mines, typically contain high concentrations of metals. Consequently, mining related activities are commonly issued discharge permits for these parameters. A spatial coverage of the mining permit data was provided by the Alabama Surface Mining Commission. The coverage includes both active and inactive coal mining facilities.

Coal mining operations typically have permits for loading of total iron, total manganese, total suspended solids, and pH (Table 3-7). There are a total of 2 active and 49 closed or expired mining discharge permits in the Hurricane Creek watershed. The mining facilities are located mainly in the northern portion of the watershed, with some facilities located along Little Hurricane Creek and Kepple Creek (Figure 3-5). A complete listing of mining permits in the Hurricane Creek watershed is located in Appendix B.

Table 3-7. Typical mining permit limits in the Hurricane Creek watershed

Parameter	Daily Minimum	Daily Average	Daily Maximum
Iron, Total (mg/L)	N/A	3.0	6.0
Manganese, Total (mg/L)	N/A	2.0	4.0
Total Suspended Solids (mg/L)	N/A	35.0	70.0
pH	6	N/A	9

Flow	Instantaneous, determine at time of sample collection
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3.4.3 Permitted Mining Data Analysis

This section examines the mining discharge data and investigates the conditions that may be contributing to elevated observed aluminum, arsenic, chromium, copper, iron, and turbidity in the Hurricane Creek watershed. The discharge monitoring report data, provided by the ADEM, was used in this analysis. Subsequently, in-stream water quality monitoring data from 11 sampling stations were also examined.

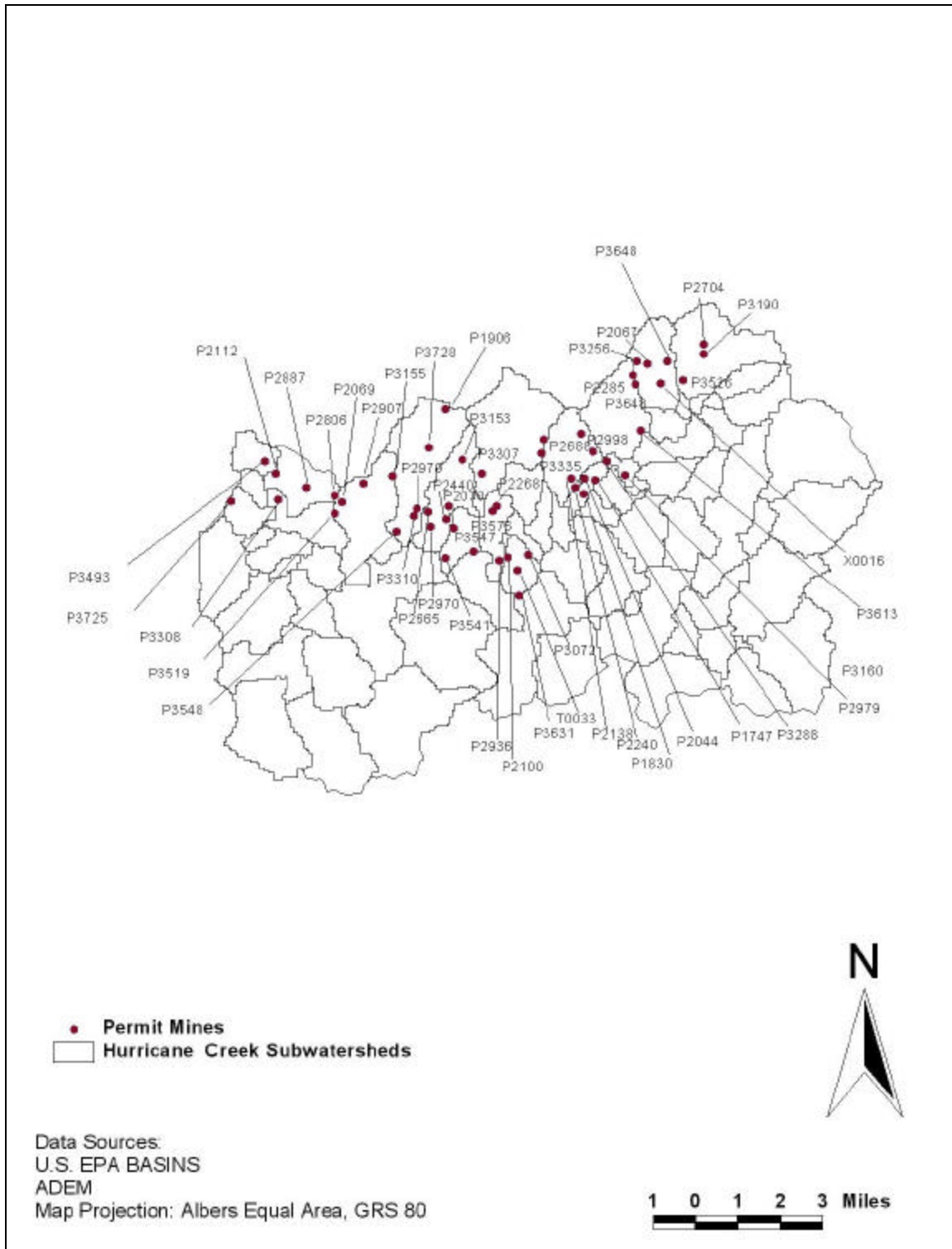


Figure 3-5. Permitted mine locations in the Hurricane Creek watershed

The LSPC hydrologic calibration process provided some insight into the nature of hydro-chemical balance in the Hurricane Creek watershed. Parameters associated with establishing the subsurface drainage balance were critical and sensitive during the hydrology calibration; therefore, it is likely that subsurface percolation and recharge influence hydrology in the watershed. During the hotter and dryer summer months, groundwater contributes a large portion of the stream flow. A comparison of flow and concentrations for iron and manganese from the mine discharge data further illustrates the influence of subsurface recharge.

A standard approach was used for evaluating the mining discharge data. The first set of analyses compared concentration changes with flow. These results are shown in Figures 3-6 through 3-9. For each observation date and pollutant of interest, a set of flow and corresponding concentration was compiled. First, the flows were categorized into ten percentile groups based on relative magnitude. Within each of those groups, a flow-weighted mean concentration was calculated. The summary table and graph are shown on the left side of each figure. Second, the flows are categorized by month. For each month, a flow-weighted mean concentration was calculated. The summary table and graph are shown on the right side of each figure. In the second set of analyses, the objective was to assess the variation of one parameter against another (Group 2 versus Group 1). These results are shown in Figures 3-9 through 3-12. The same procedure was used; however, Group 2 values were summarized based on Group 1 categories. Since flow dependency was not necessarily being considered, a weighted-average concentration was no longer meaningful. Median values within each category served as the basis for comparison.

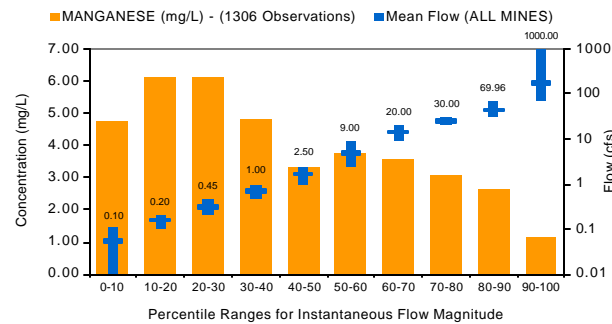
Groundwater associated minerals are dissolved and ionized in water, thereby increasing the conductivity of that water. Manganese concentrations correlate with specific conductivity in the mine discharges and both are generally higher with lower flows and in the summer months. Under normal conditions, iron conditions would follow a similar trend; however, a slightly different trend is observed.

The data indicate that higher iron concentrations generally coincide with low pH, a condition not uncommon to acid mine drainage (AMD). A discussion of AMD is presented in Section 3.3.3. Based on the understanding of both groundwater flow and AMD, it is reasonable to expect higher iron concentrations during low flow periods when groundwater recharge provides much of the surface flow, as well as during high flow periods when percolation of surface waters into the subsurface layer and AMD dominate. The precipitated substances from AMD, which are high in metals content, are thought to contribute in part to turbidity in Hurricane Creek. Other activities that result in ground disturbances, such as harvested forest, agriculture, roads, and urban/residential areas, would also contribute to higher turbidity in the streams. Turbidity is highest in the spring and generally appears to be a combined result of high runoff-erosion from disturbed land and iron precipitates formed by AMD. The influence of AMD and groundwater flow on other metals was not directly monitored, but a discussion on the chemical reactions resulting from AMD is presented in Section 3.3.3.

Model Application for TMDL Development in the Hurricane Creek Watershed

Location: ALL MINES
Pollutant: MANGANESE (mg/L)
Data from: 1/5/1983 to 3/29/2001 (1306 Observations)

Flow Range	# Obs	Flow (cfs)			Concentration (mg/L)		
Percentile	Count	Mean	Min	Max	Mean	Min	Max
0-10	131	0.055	0.000	0.100	4.77	0.05	21.00
10-20	131	0.160	0.100	0.200	6.14	0.00	41.60
20-30	130	0.318	0.200	0.450	6.10	0.10	48.60
30-40	131	0.678	0.450	1.000	4.84	0.10	39.40
40-50	130	1.668	1.000	2.500	3.36	0.00	15.00
50-60	131	4.731	2.500	9.000	3.76	0.08	14.00
60-70	131	14.337	9.220	20.000	3.60	0.06	10.50
70-80	130	25.362	20.000	30.000	3.10	0.10	16.40
80-90	130	43.644	30.000	69.960	2.63	0.10	43.00
90-100	131	169.279	70.500	1000.000	1.19	0.20	4.20



Location: ALL MINES
Pollutant: MANGANESE (mg/L)
Data from: 1/5/1983 to 3/29/2001 (1306 Observations)

Time Period	# Obs	Flow (cfs)			Concentration (mg/L)		
Month	Count	Mean	Min	Max	Mean	Min	Max
January	77	27.724	0.000	300.000	1.33	0.06	16.80
February	92	19.507	0.000	259.000	1.82	0.07	16.40
March	161	63.853	0.000	300.000	1.24	0.06	20.00
April	86	21.337	0.030	425.000	2.02	0.10	20.40
May	69	22.568	0.020	275.000	2.67	0.00	16.80
June	153	11.008	0.010	110.000	3.58	0.10	43.00
July	105	15.821	0.000	205.000	2.58	0.10	41.60
August	42	4.677	0.030	23.700	3.67	0.00	32.20
September	158	10.486	0.000	60.180	2.91	0.00	48.60
October	101	7.727	0.000	156.800	3.95	0.07	34.80
November	94	41.271	0.020	1000.000	1.39	0.05	22.60
December	168	39.042	0.030	400.000	1.68	0.10	12.60

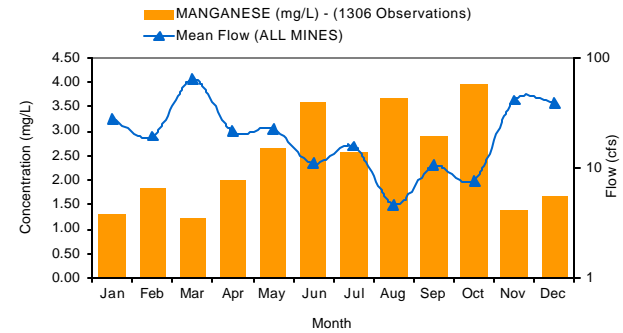
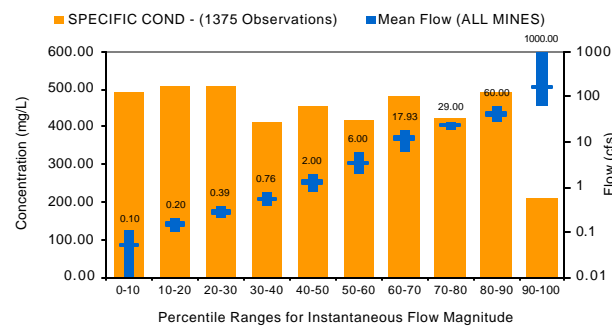


Figure 3-6. Manganese versus flow from permitted mines in the Hurricane Creek watershed

Location: ALL MINES
Pollutant: SPECIFIC COND
Data from: 1/5/1983 to 3/29/2001 (1375 Observations)

Flow Range	# Obs	Flow (cfs)			Concentration (mg/L)		
Percentile	Count	Mean	Min	Max	Mean	Min	Max
0-10	138	0.052	0.000	0.100	495.06	0.00	1670.00
10-20	137	0.150	0.100	0.200	509.76	25.00	9000.00
20-30	138	0.277	0.200	0.390	508.12	19.00	2600.00
30-40	137	0.549	0.400	0.760	410.83	20.00	2350.00
40-50	138	1.264	0.770	2.000	454.70	21.00	2120.00
50-60	137	3.412	2.000	6.000	419.26	0.00	2850.00
60-70	137	11.751	6.000	17.930	480.57	0.00	1317.00
70-80	140	23.721	18.000	29.000	423.56	52.00	1600.00
80-90	135	40.735	29.000	60.000	491.31	51.00	18010.00
90-100	138	163.929	60.180	1000.000	212.61	21.00	920.00



Location: ALL MINES
Pollutant: SPECIFIC COND
Data from: 1/5/1983 to 3/29/2001 (1375 Observations)

Time Period	# Obs	Flow (cfs)			Concentration (mg/L)		
Month	Count	Mean	Min	Max	Mean	Min	Max
January	80	26.611	0.000	300.000	155.43	0.00	855.00
February	95	16.857	0.000	259.000	141.63	22.00	1884.00
March	165	62.249	0.000	300.000	272.66	0.00	3900.00
April	91	20.176	0.030	425.000	346.10	27.00	2850.00
May	80	19.552	0.000	275.000	374.70	29.00	1820.00
June	158	10.666	0.010	110.000	415.47	24.00	2600.00
July	110	15.108	0.000	205.000	415.06	27.00	9000.00
August	48	4.106	0.010	23.700	515.55	25.00	1670.00
September	163	10.168	0.000	60.180	395.17	21.00	2100.00
October	107	7.319	0.000	156.800	1065.07	0.00	18010.00
November	102	38.091	0.020	1000.000	228.62	27.00	1320.00
December	176	37.295	0.030	400.000	241.17	19.00	1740.00

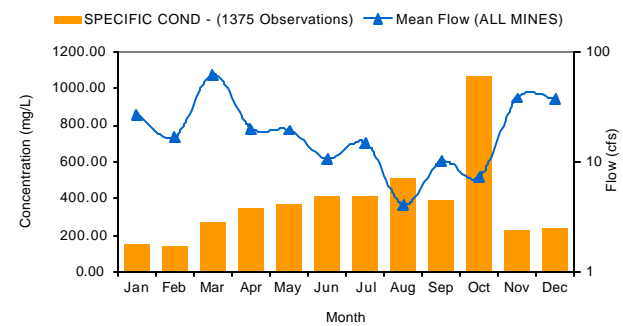


Figure 3-7. Specific conductivity versus flow from permitted mines in the Hurricane Creek watershed

Model Application for TMDL Development in the Hurricane Creek Watershed

Location: ALL MINES
Pollutant: IRON (mg/L)
Data from: 1/5/1983 to 3/29/2001 (1372 Observations)

Flow Range	# Obs	Flow (cfs)			Concentration (mg/L)		
Percentile	Count	Mean	Min	Max	Mean	Min	Max
0-10	138	0.051	0.000	0.100	1.47	0.10	16.00
10-20	137	0.150	0.100	0.200	1.65	0.08	14.50
20-30	137	0.276	0.200	0.380	1.76	0.02	17.50
30-40	137	0.546	0.390	0.750	1.64	0.08	10.26
40-50	137	1.249	0.760	2.000	1.44	0.07	12.40
50-60	137	3.380	2.000	6.000	1.52	0.04	9.88
60-70	137	11.795	6.000	17.930	0.65	0.05	5.86
70-80	138	23.925	18.000	29.000	0.55	0.02	7.67
80-90	136	41.245	29.000	60.000	0.60	0.10	4.90
90-100	138	163.929	60.180	1000.000	1.47	0.10	12.90

Location: ALL MINES
Pollutant: IRON (mg/L)
Data from: 1/5/1983 to 3/29/2001 (1372 Observations)

Time Period	# Obs	Flow (cfs)			Concentration (mg/L)		
Month	Count	Mean	Min	Max	Mean	Min	Max
January	82	26.072	0.000	300.000	2.42	0.04	16.00
February	99	18.166	0.000	259.000	1.12	0.18	12.40
March	165	62.300	0.000	300.000	0.45	0.09	10.26
April	91	20.176	0.030	425.000	3.31	0.10	7.60
May	80	19.552	0.000	275.000	2.89	0.10	8.94
June	155	10.470	0.010	110.000	0.89	0.10	13.88
July	110	15.108	0.000	205.000	0.37	0.05	15.60
August	48	4.106	0.010	23.700	0.62	0.12	10.60
September	160	10.277	0.000	60.180	0.65	0.05	17.50
October	107	7.319	0.000	156.800	0.42	0.02	9.78
November	102	38.091	0.020	1000.000	2.88	0.14	12.36
December	173	37.655	0.030	400.000	0.53	0.05	9.88

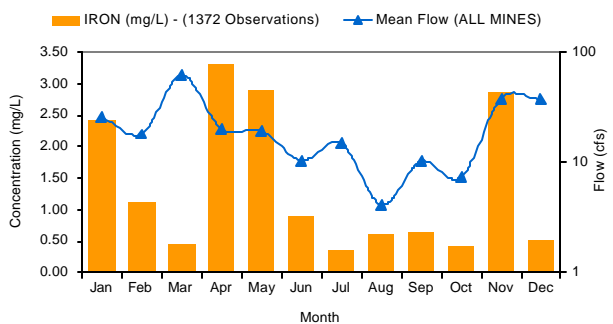
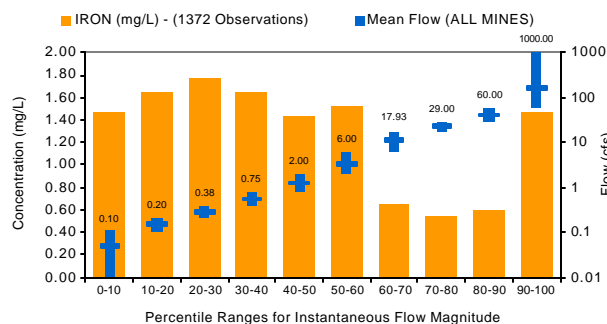


Figure 3-8. Iron versus flow from permitted mines in the Hurricane Creek watershed

Location: ALL MINES
Pollutant: TSS (mg/L)
Data from: 1/5/1983 to 3/29/2001 (1364 Observations)

Flow Range	# Obs	Flow (cfs)			Concentration (mg/L)		
Percentile	Count	Mean	Min	Max	Mean	Min	Max
0-10	137	0.051	0.000	0.100	14.31	0.16	710.00
10-20	136	0.150	0.100	0.200	15.24	0.40	376.00
20-30	136	0.278	0.200	0.400	11.87	0.80	208.80
30-40	137	0.565	0.400	0.800	14.39	0.40	134.00
40-50	136	1.315	0.800	2.000	19.60	0.40	349.60
50-60	136	3.596	2.000	6.300	18.35	0.40	242.00
60-70	137	12.179	6.400	18.000	12.09	1.20	498.00
70-80	136	24.000	18.000	29.000	13.68	0.80	194.40
80-90	136	41.474	29.000	60.180	19.25	0.80	984.00
90-100	137	164.687	60.690	1000.000	39.69	1.00	332.40

Location: ALL MINES
Pollutant: TSS (mg/L)
Data from: 1/5/1983 to 3/29/2001 (1364 Observations)

Time Period	# Obs	Flow (cfs)			Concentration (mg/L)		
Month	Count	Mean	Min	Max	Mean	Min	Max
January	80	26.713	0.000	300.000	56.10	0.40	710.00
February	98	18.349	0.000	259.000	31.13	1.60	242.00
March	163	62.970	0.000	300.000	14.05	0.80	182.00
April	88	20.848	0.030	425.000	87.45	0.40	179.20
May	79	19.433	0.000	275.000	65.21	0.40	194.40
June	157	10.721	0.010	110.000	52.01	0.40	984.00
July	107	15.288	0.000	205.000	7.27	0.16	376.00
August	48	4.106	0.010	23.700	6.49	0.40	46.00
September	162	10.230	0.000	60.180	8.01	0.40	208.80
October	106	7.114	0.000	156.800	12.73	0.80	40.00
November	101	38.468	0.020	1000.000	78.94	0.80	349.60
December	175	37.507	0.030	400.000	11.04	1.00	122.80

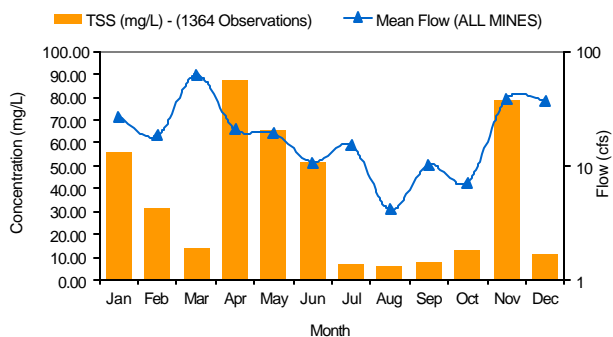
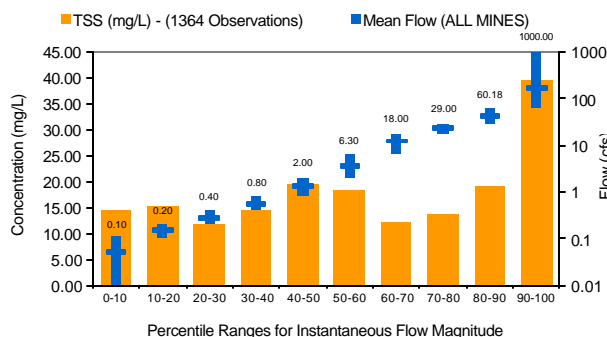


Figure 3-9. Total suspended solids versus flow from permitted mines in the Hurricane Creek watershed

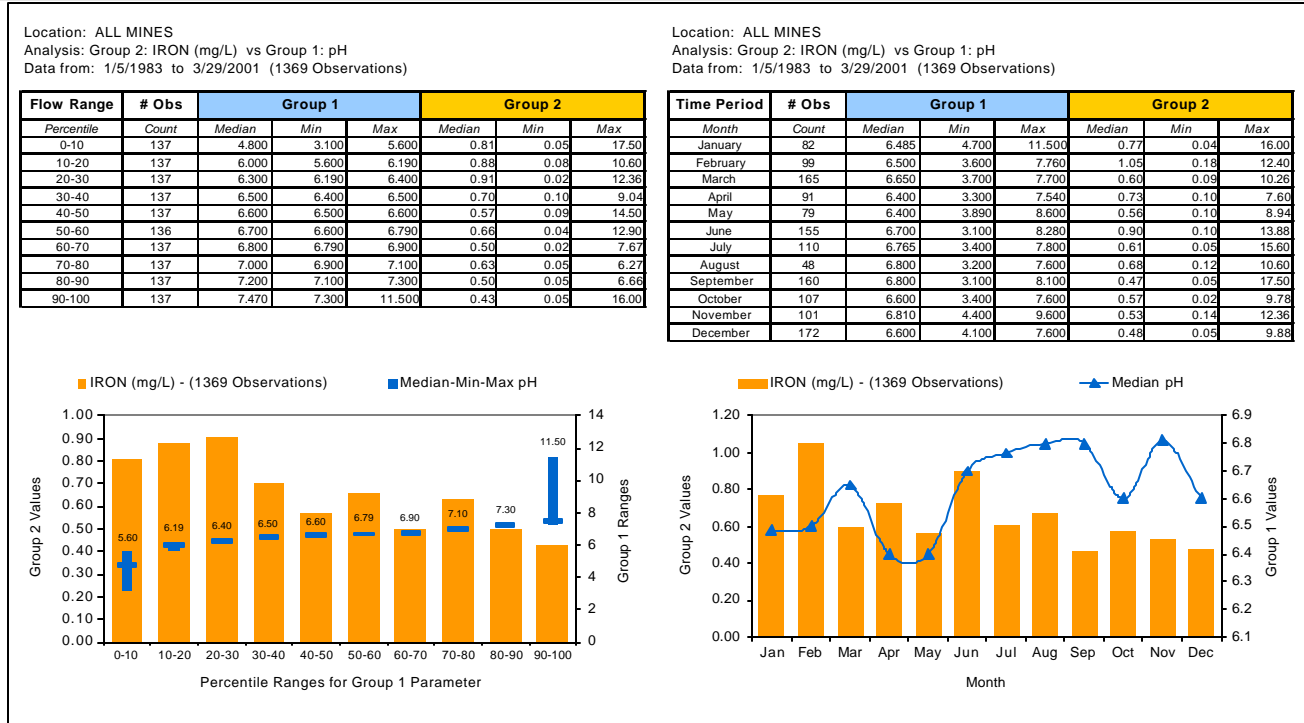


Figure 3-10. Iron versus pH at permitted mines in the Hurricane Creek watershed

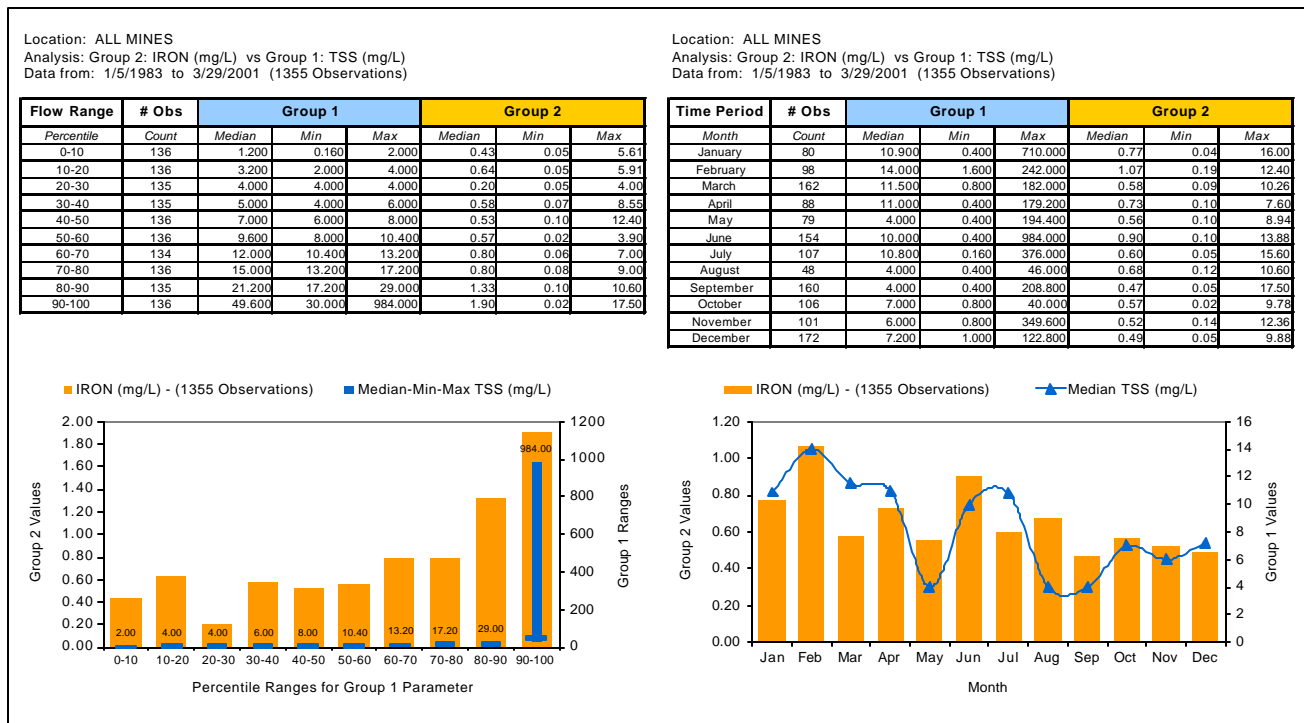


Figure 3-11. Iron versus total suspended solids at the permitted mines in the Hurricane Creek watershed

Model Application for TMDL Development in the Hurricane Creek Watershed

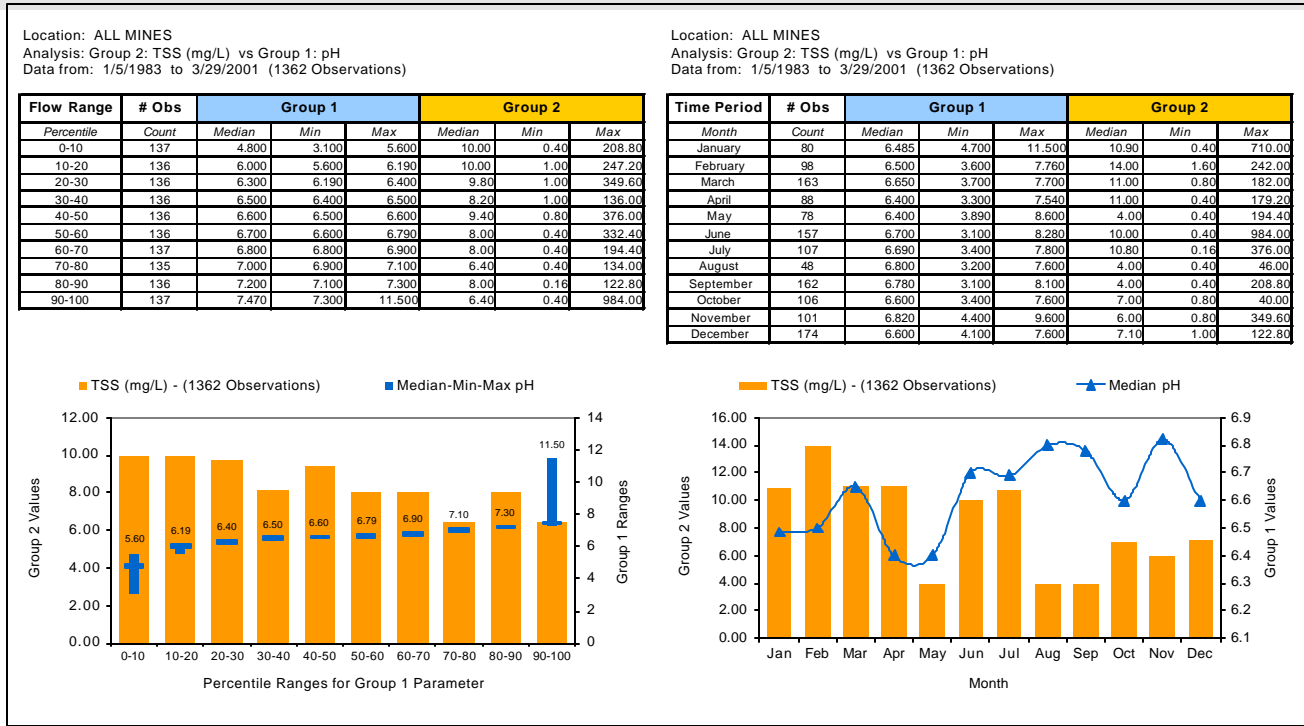


Figure 3-12. Total suspended solids versus pH at permitted mines in the Hurricane Creek watershed

4.0 Technical Approach

Establishing the relationship between the in-stream water quality targets and source loadings is a critical component of TMDL development. It allows for evaluation of management options that will achieve the desired source load reductions. The link can be established through a range of techniques, from qualitative assumptions based on sound scientific principles to sophisticated modeling techniques. The objective of this section is to present the approach taken to develop the linkage between sources and in-stream response for TMDL development in the Hurricane Creek watershed.

4.1 Model Framework Selection

Selection of the appropriate approach or modeling technique required consideration of the following:

- \$ Expression of water quality criteria
- \$ Dominant processes
- \$ Scale of analysis

The relevant criteria for metals, pathogens, and turbidity were presented in Section 2. Numeric criteria, such as those applicable here, require evaluation of magnitude, frequency, and duration. Thresholds of a numeric measure are often evaluated for frequency of exceedance (e.g., not to exceed more than once every 3 years on average). Acute standards typically require evaluation over short time periods and violations may occur under variable flow conditions. Chronic criteria require the evaluation of the response over a four-day averaging period. The fecal coliform criteria are presented as either a geometric mean using a minimum of 5 consecutive samples over a 30-day period or an instantaneous maximum standard. The approach or modeling technique must permit representation of in-stream concentrations under a variety of flow conditions in order to evaluate critical periods for comparison to chronic and acute criteria.

The appropriate approach must also consider the dominant processes regarding pollutant loadings and in-stream fate. For the Hurricane Creek watershed, primary sources contributing to metals, pathogens, and turbidity impairments include an array of nonpoint or diffuse sources as well as discrete point sources/permitted discharges. Loading processes for nonpoint sources or land-based activities are typically rainfall-driven and thus relate to surface runoff and subsurface discharge to a stream. Permitted discharges may or may not be dependent on rainfall, however, they are controlled by permit limits.

Key in-stream factors that must be considered include routing of flow, dilution, transport, and fate (decay or transformation) of metals, pathogens, and turbidity. In the stream systems of the Hurricane Creek watershed, the primary physical driving process is the transport of metals by diffusion and advection in the flow. Significant chemical processes are the speciation and precipitation of metals followed by sediment adsorption/desorption and redox reactions related to the precipitation reactions. Significant in-stream processes affecting the transport of fecal coliform and sediment include fecal coliform die-off, and deposition and resuspension of sediments.

Scale of analysis and waterbody type must also be considered in the selection of the overall approach. The approach should have the capability to evaluate watersheds at multiple scales, particularly those of

a few hundred acres in size. Selection of scale should be sensitive to locations of key features, such as abandoned mines and point source discharges. At the larger watershed scale, land areas are lumped into subwatersheds for practical representation of the system, commensurate with the available data. Occasionally, there are site specific and localized acute problems that may require more detailed segmentation or definition of detailed modeling grids.

Based on the considerations described above, analysis of the monitoring data, review of the literature, and past metals, pathogens, and turbidity modeling experience, the Loading Simulation Program C++ (LSPC) was used to represent the source-response linkage in the Hurricane Creek watershed. LSPC is a comprehensive data management and modeling system that is capable of representing loading from nonpoint and point sources found in the Hurricane Creek watershed and simulating in-stream processes. LSPC is based on the Mining Data Analysis System (MDAS), with modifications for non-mining applications. MDAS was developed by EPA Region 3 through mining TMDL applications in Region 3. MDAS has been used in mining TMDL development for the Tygart Valley River, Monongahela River, and Stony River in West Virginia.

4.2 Loading Simulation Program C++ (LSPC) Overview

LSPC is a system designed to support TMDL development for areas impacted by nonpoint and point sources. LSPC is also capable of supporting TMDL development for pollutants not related to AMD, such as fecal coliform and sediment. The system integrates the following:

- \$ Graphical interface
- \$ Data storage and management system
- \$ Dynamic watershed model
- \$ Data analysis/post-processing system

The graphical interface supports basic geographic information systems (GIS) functions, including electronic geographic data importation and manipulation. Key data sets include stream networks, landuse, flow and water quality monitoring station locations, weather station locations, and permitted facility locations. The data storage and management system functions as a database and supports storage of all data pertinent to TMDL development, including water quality observations, flow observations, permitted facility DMRs, as well as stream and watershed characteristics used for modeling. The system also includes functions for inventorying the data sets. The dynamic watershed model simulates nonpoint source flow and pollutant loading as well as in-stream flow and pollutant transport, and it is capable of representing time-variable point source contributions. The data analysis/post-processing system conducts correlation and statistical analyses and enables the user to plot model results and observation data.

The most critical component of LSPC to TMDL development is the dynamic watershed model, because it provides the linkage between source contributions and in-stream response. The comprehensive watershed model is used to simulate watershed hydrology and pollutant transport as well as stream hydraulics and in-stream water quality. It is capable of simulating flow, sediment, metals, nutrients, pesticides, and other conventional pollutants, as well as temperature and pH for pervious and impervious lands and waterbodies. This model is essentially a re-coded C++ version of selected

Hydrologic Simulation Program-FORTRAN (HSPF) modules. LSPC's algorithms are identical to those in HSPF. Table 4-1 presents the modules from HSPF used in the LSPC dynamic watershed model. Refer to the *Hydrologic Simulation Program FORTRAN User's Manual for Release 11* for a more detailed discussion of simulated processes and model parameters (Bicknell et al. 1996).

Table 4-1. Modules from HSPF^a used in LSPC

RCHRES Modules	HYDR	Simulates hydraulic behavior
	ADCALC	Simulates advection of constituents
	CONS	Simulates conservative constituents
	HTRCH	Simulates heat exchange and water
	SEDTRN	Simulates behavior of inorganic sediment
	GQUAL	Simulates behavior of a generalized quality constituent
	PHCARB	Simulates pH, carbon dioxide, total inorganic carbon, and alkalinity
PQUAL and IQUAL Modules	PWATER/IWATER	Simulates water budget for a pervious land segment
	SEDMNT	Simulates production and removal of sediment
	PWTGAS	Estimates water temperature and dissolved gas concentrations
	PQUAL/IQUAL	Simulates pollutant loading using simple relationships with solids and water yield

^a Source: Bicknell et al. 1996

4.3 Model Configuration

LSPC was configured for the Hurricane Creek watershed to simulate the watershed as a series of hydrologically connected subwatersheds. Configuration of the model involved subdivision of the Hurricane Creek watershed into modeling units and continuous simulation of flow and water quality for these units using meteorological, landuse, point source loading, and stream data. Specific pollutants that were simulated include aluminum, arsenic, copper, chromium, iron, fecal coliform, and TSS. This section describes the configuration process and key components of the model in greater detail.

4.3.1 Watershed Subdivision

To represent watershed loadings and resulting concentrations of metals, fecal coliform, and TSS in Hurricane Creek, North Fork Hurricane Creek, and Little Hurricane Creek, the watershed was divided into 72 subwatersheds. These subwatersheds are presented in Figure 4-1, and represent hydrologic boundaries. The division was based on elevation data (7.5 minute Digital Elevation Model [DEM] from USGS), stream connectivity (from EPA's Reach File, Version 3 [RF3] stream coverage), and locations of monitoring stations.

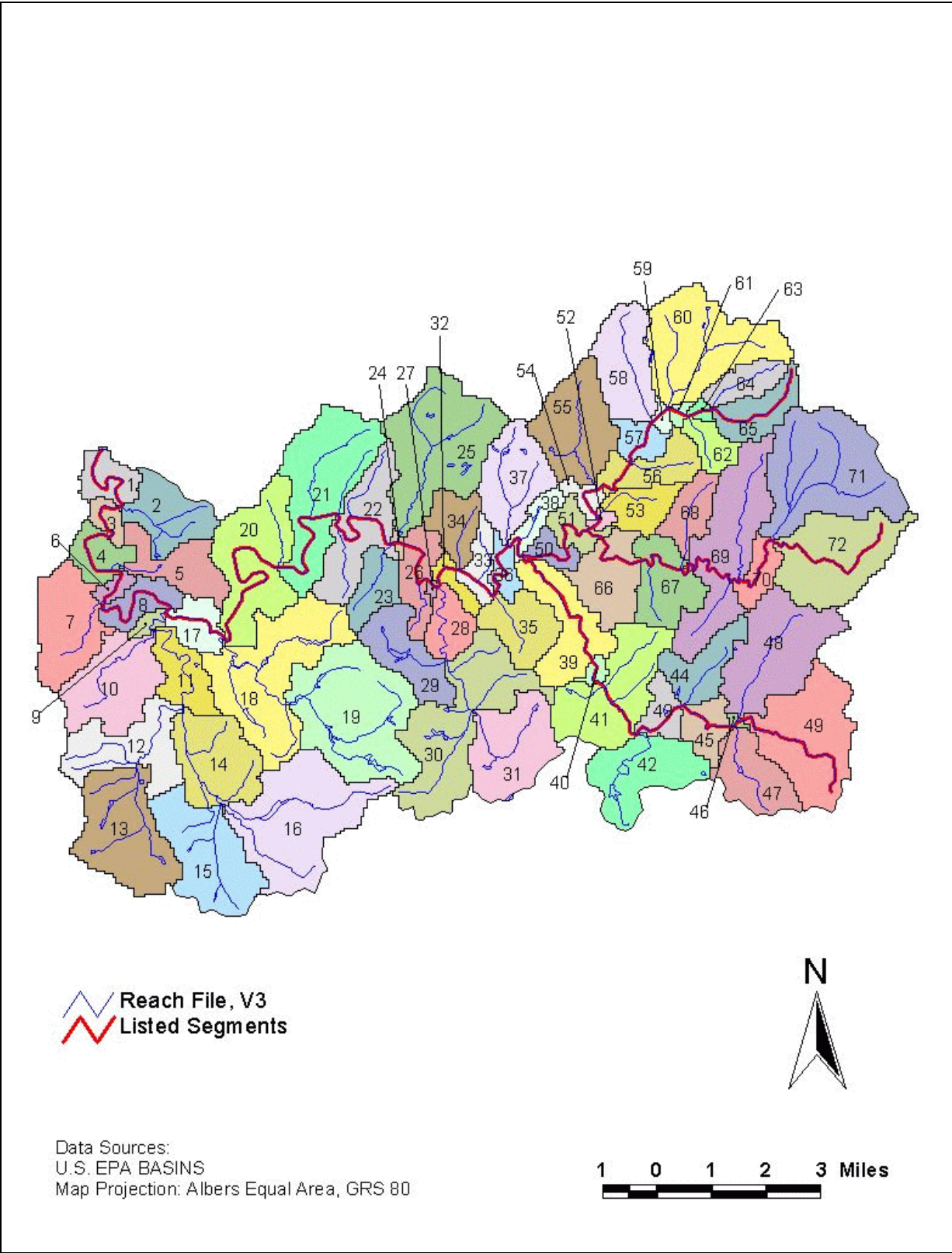


Figure 4-1. Subwatersheds in the Hurricane Creek basin

4.3.2 Meteorological Data

Meteorological data are a critical component of the watershed model. Appropriate representation of precipitation, potential evapotranspiration, cloud cover, temperature, and dewpoint are required to develop a valid model. Meteorological data were accessed from a number of sources in an effort to develop the most representative dataset for the Hurricane Creek watershed.

In general, hourly precipitation data are recommended for nonpoint source modeling due to the storm sensitive processes. Therefore, only weather stations with hourly-recorded data were considered in development of a representative dataset. Long-term hourly precipitation data available from two National Climatic Data Center (NCDC) weather stations located near the watershed were used (Figure 4-2):

- \$ Tuscaloosa Oliver Dam
- \$ Birmingham FAA Airport

LSPC was calibrated for hydrology using 1960s flow data and again using flow data from 1980 (see Section 4.4.1). The Birmingham Airport weather data was used during the 1960s time period because the quality of the rainfall data at Birmingham Airport was higher than Tuscaloosa Oliver Dam at this time period. The Tuscaloosa Oliver Dam station was used for the 1980 calibration due to its closer proximity to the watershed. These weather data were applied to all subwatersheds in the Hurricane Creek watershed.

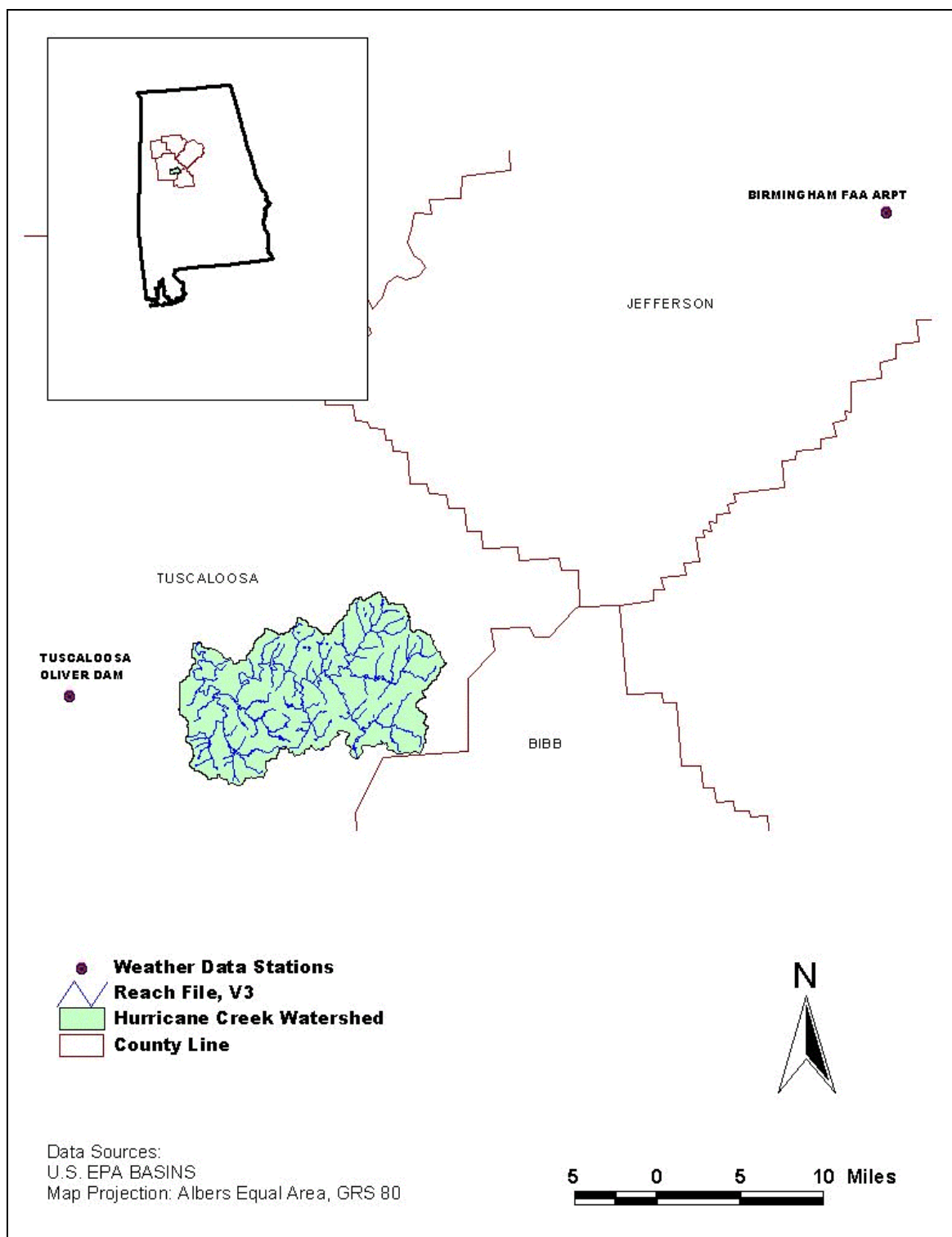


Figure 4-2. Weather stations used in modeling

4.3.3 Nonpoint Source Representation

The nonpoint sources in the Hurricane Creek watershed are presented differently in the model depending on their type and behavior.

The MRLC land use categories were reclassified into eight land use categories that best describe the watershed conditions and dominant source categories. The eight land uses represent nonpoint sources, including barren land, cropland, forest, pasture, strip mining, urban impervious, urban pervious, and wetlands. The land use reclassification is shown in Table 4-2.

Table 4-2. Model land use reclassification

Model Category	MRLC Category
Barren	Bare Rock/Sand/Clay
	Transitional Barren
	Bare Soil
Crop land	Row Crops
	Small Grains
Forest	Deciduous Forest
	Evergreen Forest
	Mixed Forest
	Deciduous Shrub land
	Evergreen Shrub land
	Mixed Shrub land
	Non-Natural Woody (Orchards/Groves/etc)
Pasture	Grasslands/Herbaceous (Natural/Semi Natural Herbaceous)
	Pasture/Hay
	Other Grasses/(Urban Grasses)
Strip Mining	Quarries/Strip Mines/Gravel Pits
Urban Impervious	Low Intensity Residential
	High Intensity residential
	High Intensity Commercial/Industrial/Transportation
Urban Pervious	Low Intensity Residential
	High Intensity residential
	High Intensity Commercial/Industrial/Transportation
Wetlands	Woody Wetlands
	Emergent Herbaceous Wetlands

The land uses of paved roads, unpaved roads, and harvested forest were also included in the model, but these land uses were not explicitly represented in MRLC. The areas of these land uses were obtained from various sources (See Section 3 Source Assessment). These areas were superimposed on the MRLC land use data, which was then corrected to account for these changes. The land use coverage was used as the basis for estimating metals, fecal coliform, and TSS loadings. The assumed pervious and impervious percentage for each land use, which affects the hydrology and water quality of the Hurricane Creek watershed, is listed in Table 4-3. These percentages are based on the average percent impervious area of different land use types found in the Soil Conservation Service's Urban Hydrology for Small Watersheds manual (USDA-SCS, 1986).

Table 4-3. Average percent perviousness and imperviousness for different land use types

Landuse	Pervious (%)	Impervious (%)
Pasture	100	0
Crop	100	0
Forest	100	0
Barren	100	0
Strip mine	100	0
High density commercial/industrial/transportation (urban impervious)	15	85
Lower density residential (urban pervious)	88	12
Paved roads	0	100
Unpaved roads	100	0
Harvested forest	100	0
Wetlands	100	0

Abandoned Mine Lands (AML)

In order to represent AMLs as nonpoint sources, the AML sites were represented as a unique land use category called "abandoned mines". The abandoned mines represent either discharge from abandoned deep mines or seeping and leaching from other abandoned mine sites. Abandoned mine locations and areas were obtained from the Alabama Abandoned Mine Land Reclamation Division. The AML locations were compared to the location of disturbed mine area provided by ADEM. When AML sites were located within the disturbed mine area, the AML acres were subtracted from the disturbed mine area. When AML sites were not located near any disturbed mines areas, the acres were subtracted from the forest land use.

Fecal Coliform Sources

The nonpoint fecal coliform sources within the Hurricane Creek watershed are represented differently in the model depending on their type and behavior. The following nonpoint fecal coliform sources have been identified within the listed watersheds:

- \$ General land-based runoff
- \$ Grazing livestock
- \$ Wildlife
- \$ Failing septic systems
- \$ Cattle in the stream reaches

Typically, nonpoint sources are characterized by buildup and washoff processes: they contribute bacteria to the land surface, where they accumulate and are available for runoff during storm events.

These nonpoint sources can be represented in the model as land-based runoff from the land use categories to account for their contribution to coliform loading within the watersheds. Fecal coliform accumulation rates (number per acre per day) can be calculated for each land use based on all sources contributing coliform to the surface of the land use. For this study, where specific sources were identified as contributing to a land use, accumulation rates were calculated. For example, grazing livestock and wildlife are specific sources contributing to land uses within the watershed. The land uses that experience bacteria accumulation due to livestock and wildlife include

- \$ Cropland (wildlife)
- \$ Forest (wildlife)
- \$ Pasture (livestock and wildlife)
- \$ Wetlands (wildlife)

Accumulation rates can be derived using the distribution of animals by land use and using typical fecal coliform production rates for different animal types (Table 4-4). For example, the coliform accumulation rate for pasturelands is the sum of the individual coliform accumulation rates due to contributions from grazing livestock (cattle and hogs) and wildlife.

Table 4-4. Fecal coliform production rates for various animals

Animal	Fecal Coliform Production Rate	Reference
Beef cow	1.0×10^{11} counts/day	ASAE, 1998
Hog	8.9×10^9 counts/day	Metcalf & Eddy, 1991
Deer	5×10^8 counts/day	Linear interpolation; Metcalf & Eddy, 1991

Literature values for typical fecal coliform accumulation rates were used for the urban/residential land uses. The literature value used for residential land uses is $1.43 \text{ E}+07$ #/ac/day, the average of the default values for low- and high-density residential areas (Horner, 1992). The literature value used for urban land uses is the median default value of $6.19 \text{ E}+06$ #/ac/day for commercial land (Horner, 1992).

Failing septic systems represent a nonpoint source that can contribute fecal coliform to receiving waterbodies through surface or subsurface malfunctions. The estimation of number of failing septic systems is discussed in Section 3. To provide for a margin of safety accounting for the uncertainty of the number, location, and behavior (e.g., surface vs. subsurface breakouts; proximity to stream) of the failing systems, failing septic systems are represented in the model as direct sources of fecal coliform to the stream reaches. Fecal coliform contributions from failing septic system discharges are included in the model with a representative flow and concentration, which were quantified based on the following information:

- Number of failing septic systems in each subwatershed (as discussed in Section 3).
- Estimated population served by the septic systems (average of county averages of people per household, obtained from 1990 Bureau of the Census data).
- An average daily discharge of 70 gallons/person/day (Horsley & Witten, 1996).
- Septic effluent concentration of 10^4 cfu/100 mL (Horsley & Witten, 1996).

Cattle depositing manure directly into stream reaches also represent a direct nonpoint source of fecal coliform. The number of cattle producing and depositing fecal coliform in watershed streams at any give time were estimated, as discussed in Section 3. The cattle were then simulated in the model as direct sources of fecal coliform loads, with a representative flow rate (cubic feet per second) and load (counts per hour). The representative load was calculated based on the number of cows in the stream and the fecal coliform production rate for cows (Table 4-4). The flow was estimated based on the number of cows in the stream, the manure production rate of cows (ASAE, 1998) and the approximate density of cow manure.

Nonpoint Source Loading estimates for Sediment and Metals

As with fecal coliform, TSS nonpoint sources are typically characterized by buildup and washoff processes. Based on analysis of the water quality data in Hurricane Creek watershed, possible nonpoint sources of TSS include abandoned mines, strip mining, barren land, harvested forest, forest, roads, and agriculture. The contributions of TSS to the watershed from these sources is discussed in Section 3. Soils detachment by rainfall on the contributing land uses is represented in the sediment module of LSPC. The detached sediment removed by surface flow and is washed off into the stream reach where it eventually settles or is resuspended in the water column.

In order to determine land use specific nonpoint source pollution parameters for Hurricane Creek, Alabama, local estimates of total annual eroded sediment (in tons) were available for various land use types within the watershed including cropland, mined land, developing urban land, dirt roads and road banks, and woodlands (ADEM 2001). These erosion estimates were used as a basis for determining sediment and metal loading rates for the Loading Simulation Program—C++ (LSPC) watershed model.

Because the areas occupied by different land use classes within the watershed are known, land use specific erosion rates could be established. Estimates were made for the land use categories where annual sediment yield data were not provided. The relative magnitudes of sediment loading from each land use in the Hurricane Creek watershed provided guidance for adjusting the sediment coefficients.

The sediment loading information was also used to find metal build-up rates. Erosion is linked to the metals loading to the streams because of the naturally high metals concentrations in the soils of the watershed. It is also thought that iron precipitates from acid mine drainage contribute to increased turbidity in the Hurricane Creek watershed. The relative magnitudes from land use associated sediment loading information were used as the initial values for metal build-up rates. Through calibration, these rates were further refined to represent observed metals concentrations in the Hurricane Creek watershed.

Subwatersheds without mining sources may produce high metals concentrations due to the naturally high concentrations of metals in the soils and bedrock in the watershed and their association with sediment. As configured, LSPC does not directly link reductions in sediment to reductions in metals, but based on the assumption that high metals loadings are associated with increased sediment delivery to the watershed, it is assumed that reduction in sediment would in turn result in a reduction of metals to the watershed.

4.3.4 Point Sources Representation

Permitted Non-mining Point Sources

There are only three non-mining point source permits in the Hurricane Creek watershed. The point sources are permitted to discharge TSS. These point sources are included in the model with a constant flow. The representative constant flow is the design flow provided in the NPDES permit of each facility. The three non-mining point sources are not required to record their fecal coliform discharges, but based on their identification as municipal facilities, it is assumed that they do discharge fecal coliform. The facilities are represented in the LSPC model by a discharge of 200 counts/100 mL. These are minor facilities and most likely do not represent a significant source of turbidity or fecal coliform to the watershed.

Permitted Mining Point Sources

To account for the permitted mining point sources in the watershed, the disturbed mine areas provided by Alabama Surface Mining Commission were overlayed on the MRLC land use coverage and land use areas covered by disturbed mine were subtracted from the watershed and replaced by the disturbed mine area. The disturbed mine area was added to the remaining strip mining land use. The size of each mine was assumed to be equivalent to the surface disturbed area. Specific disturbed acreage was not available for the underground mines, therefore an area of 1 acre per mine opening or portal was assumed for their initial inclusion in LSPC. The area of underground mines can be refined based on the metals loadings in the mines= respective subwatersheds. A summary of the land use distribution is shown in Table D-1 in Appendix C.

4.3.5 Stream Representation

Modeling subwatersheds and calibrating hydrologic and water quality model components required the routing of flow and pollutants through streams. Each subwatershed was represented with a single stream. Stream segments were identified using EPA's RF3 stream coverage.

In order to route flow and pollutants, development of rating curves was required. Rating curves were developed for each stream using Manning's equation and representative stream data. Required stream data includes slope, Manning's roughness coefficient, and stream dimensions including mean and channel widths and depths. Manning's roughness coefficient was assumed to be 0.05 for all streams (representative of natural streams). Slopes were calculated based on digital elevation model (DEM) data and stream lengths measured from the RF3 stream coverage. Stream dimensions were estimated using regression curves that relate upstream drainage area to stream dimensions (Rosgen, 1996).

4.3.6 Hydrologic Representation

Hydrologic processes were represented in LSPC using algorithms from the PWATER (water budget simulation for pervious land segments) and IWATER (water budget simulation for impervious land segments) modules of HSPF (Bicknell et al., 1996). Parameters associated with infiltration, groundwater flow, and overland flow were designated during model calibration.

4.3.7 Pollutant Representation

In addition to flow, six pollutants were modeled with LSPC:

- \$ Total aluminum
- \$ Total arsenic
- \$ Total chromium
- \$ Total copper
- \$ Total iron
- \$ Fecal coliform bacteria
- \$ TSS

The loading contributions of these pollutants from different nonpoint sources were represented in LSPC using the PQUAL (simulation of quality constituents for pervious land segments) and IQUAL (simulation of quality constituents for impervious land segments) modules from HSPF (Bicknell et al., 1996). Pollutant transport was represented in the streams using the GQUAL (simulation of behavior of a generalized quality constituent) and SEDMNT (simulation of sediment and its associated quality constituents) modules. Values for the pollutant representation will be refined through the water quality calibration process.

4.4 Model Calibration

After the model was configured, calibration was performed at multiple locations throughout the Hurricane Creek watershed. Calibration refers to the adjustment or fine-tuning of modeling parameters to reproduce observations. Model calibration focused on two main areas: hydrology and water quality.

Upon completion of the calibration at selected locations, a calibrated dataset containing parameter values for modeled sources and pollutants was developed. This dataset was applied to areas where calibration data were not available.

A significant amount of time-varying monitoring data were necessary to calibrate the model. Available monitoring data in the watershed were identified and assessed for application to calibration. Only monitoring stations with data representing a range of hydrologic conditions, source types, and pollutants were selected. The locations selected for calibration are presented in Figure 4-3.

4.4.1 Hydrology Calibration

Hydrology was the first model component calibrated. The hydrology calibration involved a comparison of model results to in-stream flow observations at selected locations and the subsequent adjustment of

hydrologic parameters. Key considerations included the overall water balance, the high-flow/low-flow distribution, storm flows, and seasonal variation.

To best represent hydrologic variability throughout the watershed, two locations with daily flow monitoring data were selected for calibration. The stations were USGS #02463500 on Hurricane Creek and USGS #02463510 on Hurricane Creek. Recent time series flow data were not available for hydrology calibration in the Hurricane Creek watershed, therefore, the model was calibrated for two earlier time periods. The model was calibrated using flow data at USGS gage 2463510 for the 10-year period of 1960-1969. This time period represents pre-mining conditions in the watershed, so the model was calibrated based on the original land uses (disturbed mining area was not included). Mining was more prevalent after the 1960s, so after the 10-year 1960s calibration, the mining land uses were added to the model and it was re-calibrated using USGS flow gage 2463500, a station close to 2463510 that has flow data for the time period of 10/1/80 to 9/30/81. This is the most recent time series flow data available in the watershed. The model was calibrated for the years 1960-1969 and 1980 because these were the most recent flow data available and represent a range of hydrologic conditions. Temporal comparisons and comparisons of high flows and low flows were developed to support calibration. The calibration involved adjustment of infiltration, subsurface storage, evapotranspiration, surface runoff, and interception storage parameters.

After adjusting the appropriate parameters within acceptable ranges, good correlations were found between model results and observed data for the comparisons made. Temporal analyses are presented in Appendix D.

The calibrated parameter values were validated for an independent, extended time period between 1982 and 1987 after calibrating hydrology parameters at the stations. Validation involved comparison of model results and flow observations without further adjustment of parameters. The validation comparisons also showed a good correlation between modeled and observed data. Refer to Appendix D for validation results.

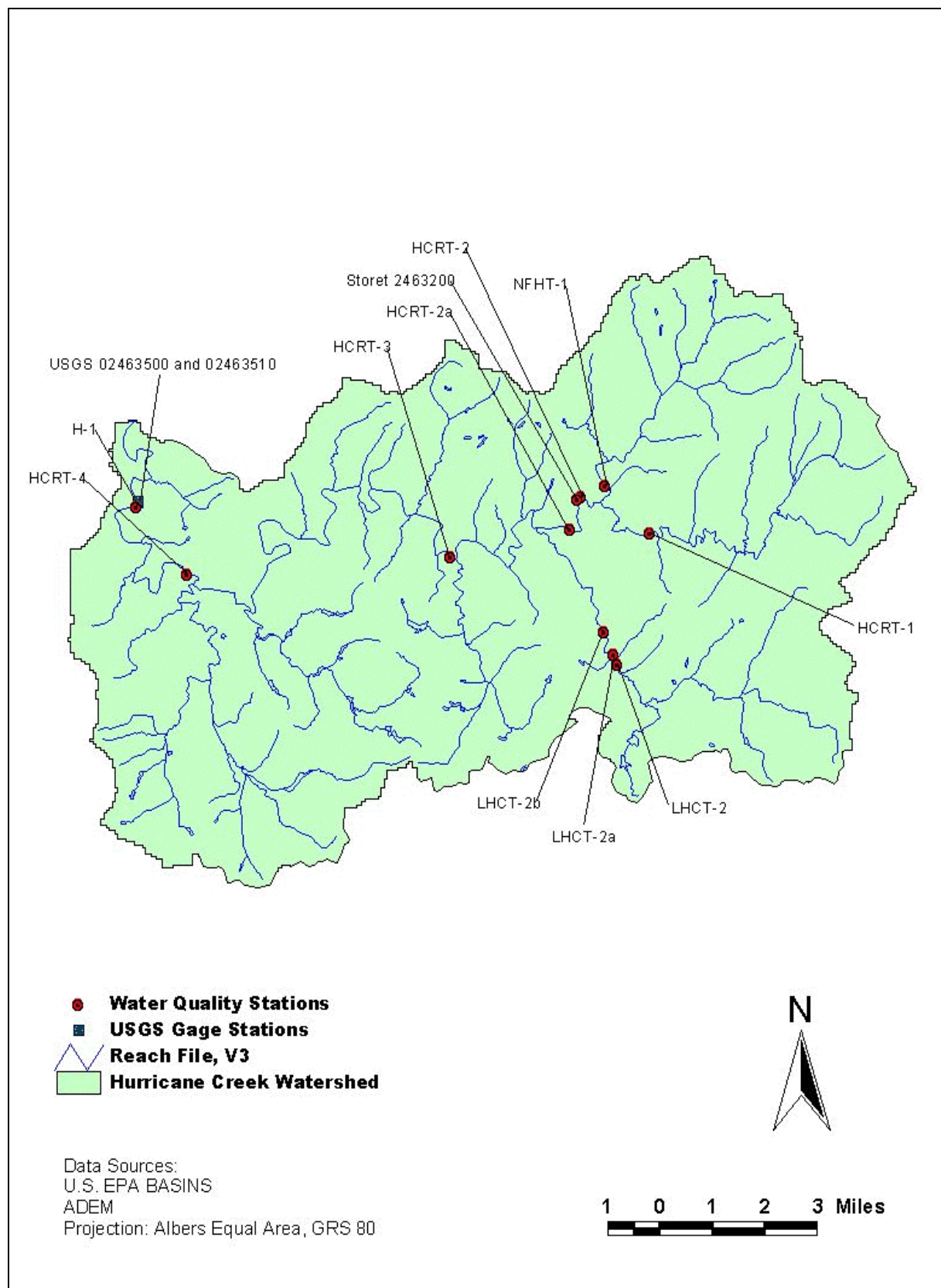


Figure 4-3. Calibration locations used in modeling

4.4.2 Water Quality Calibration

Following hydrology calibration, the water quality constituents were calibrated. Modeled versus observed in-stream concentrations were directly compared during model calibration. The water quality calibration consisted of executing the watershed model, comparing water quality time series output to available water quality observation data, and adjusting water quality parameters within a reasonable range.

The approach taken to calibrate water quality focused on matching trends identified during the water quality analysis. Daily average in-stream concentrations from the model were compared directly to observed data. Observed data were obtained from EPA's STORET database as well as from a 1996 water quality study performed by ADEM in the Hurricane Creek watershed. The objective was to best simulate low flow, mean flow, and storm peaks at representative water quality monitoring stations. The model was calibrated for all water quality stations with observation data during the chosen calibration period. These stations were typically ADEM monitoring stations.

The time period of the model simulation was from 1992 through 1998. This time period was selected based on the availability and relevance of the observed data to the current conditions in the watershed. The most comprehensive water quality data is available at the H-1 station near the downstream portion of the watershed (Subwatershed 4). In 1996, spatially distributed data at the eight ADEM stations were available. These observations were taken on four days in the June and August (June 11 and 12 and August 27 and 28). For each pollutant, model results were plotted against these data to assess the model's response to spatial variation of loading sources. For fecal coliform, aluminum, copper, and iron, model results were also plotted against in-stream data at station H-1 from 1993 through 1998. Since metal sources are thought to originate from similar sources, modeling parameters were adjusted similarly for all metals. Due to the limited amount of data to show otherwise, it is assumed that arsenic, and chromium will follow similar loading patterns as the other metals, though the magnitude of variation will correlate with the few observed concentrations. The results of the water quality calibrations for each of the listed pollutants are presented in Appendix E.

Hurricane Creek Modeling Report Appendix A
Water Quality Data and Analysis

Table A-1. Water quality data at STORET station 02463200

Parameter Number	Parameter Name	Date Sampled	Sample (ug/L)
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1105	ALUMINUM AL,TOT UG/L	3/17/80	530
1105	ALUMINUM AL,TOT UG/L	3/17/80	630
1105	ALUMINUM AL,TOT UG/L	3/17/80	580
1105	ALUMINUM AL,TOT UG/L	3/17/80	4200
1105	ALUMINUM AL,TOT UG/L	3/20/80	96000
1105	ALUMINUM AL,TOT UG/L	3/28/80	4200
1105	ALUMINUM AL,TOT UG/L	7/31/80	2400
1105	ALUMINUM AL,TOT UG/L	8/25/80	3900
1105	ALUMINUM AL,TOT UG/L	1/21/81	900
1105	ALUMINUM AL,TOT UG/L	8/31/81	3900
1002	ARSENIC AS,TOT UG/L	7/31/80	1
1002	ARSENIC AS,TOT UG/L	1/21/81	1
1002	ARSENIC AS,TOT UG/L	8/31/81	1
1034	CHROMIUM CR,TOT UG/L	7/31/80	20
1034	CHROMIUM CR,TOT UG/L	1/21/81	10
1034	CHROMIUM CR,TOT UG/L	8/31/81	10
1042	COPPER CU,TOT UG/L	7/16/80	11
1042	COPPER CU,TOT UG/L	7/31/80	8
1042	COPPER CU,TOT UG/L	1/21/81	3
1042	COPPER CU,TOT UG/L	8/31/81	14

Table A-2. ADEM water quality observations

Station	Parameter Code	Parameter Name	Date	Value
H1	1105	ALUMINUM AL TOT UG/L	3/14/84	400
H1	1105	ALUMINUM AL TOT UG/L	3/7/85	1600
H1	1105	ALUMINUM AL TOT UG/L	9/26/85	500
H1	1105	ALUMINUM AL TOT UG/L	6/7/94	500
H1	1105	ALUMINUM AL TOT UG/L	9/9/94	500
H1	1105	ALUMINUM AL TOT UG/L	12/20/94	2910
H1	1105	ALUMINUM AL TOT UG/L	12/13/95	840
H1	1002	ARSENIC AS TOT UG/L	6/3/81	10
H1	1002	ARSENIC AS TOT UG/L	9/1/81	5
H1	1002	ARSENIC AS TOT UG/L	6/3/82	10
H1	1002	ARSENIC AS TOT UG/L	9/23/82	10
H1	1002	ARSENIC AS TOT UG/L	12/14/83	10
H1	1002	ARSENIC AS TOT UG/L	3/14/84	10
H1	1002	ARSENIC AS TOT UG/L	6/21/84	10
H1	1002	ARSENIC AS TOT UG/L	9/11/84	10
H1	1002	ARSENIC AS TOT UG/L	12/5/84	10
H1	1002	ARSENIC AS TOT UG/L	3/7/85	10
H1	1002	ARSENIC AS TOT UG/L	6/14/85	10
H1	1002	ARSENIC AS TOT UG/L	9/26/85	10
H1	1002	ARSENIC AS TOT UG/L	12/11/85	10
H1	1002	ARSENIC AS TOT UG/L	3/13/86	10
H1	1002	ARSENIC AS TOT UG/L	6/5/86	10
H1	1002	ARSENIC AS TOT UG/L	9/12/86	10
H1	1002	ARSENIC AS TOT UG/L	12/3/86	10
H1	1002	ARSENIC AS TOT UG/L	3/20/87	10
H1	1002	ARSENIC AS TOT UG/L	6/11/87	10
H1	1002	ARSENIC AS TOT UG/L	9/9/87	10
H1	1002	ARSENIC AS TOT UG/L	12/3/87	10
H1	1002	ARSENIC AS TOT UG/L	3/10/88	10
H1	1002	ARSENIC AS TOT UG/L	6/9/88	10
H1	1002	ARSENIC AS TOT UG/L	9/27/88	10

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Station	Parameter Code	Parameter Name	Date	Value
H1	1002	ARSENIC AS TOT UG/L	12/7/88	10
H1	1002	ARSENIC AS TOT UG/L	3/15/89	10
H1	1002	ARSENIC AS TOT UG/L	7/12/89	10
H1	1002	ARSENIC AS TOT UG/L	9/21/89	10
H1	1002	ARSENIC AS TOT UG/L	1/17/90	10
H1	1002	ARSENIC AS TOT UG/L	3/14/90	10
H1	1002	ARSENIC AS TOT UG/L	6/7/90	10
H1	1002	ARSENIC AS TOT UG/L	9/26/90	10
H1	1002	ARSENIC AS TOT UG/L	12/12/90	10
H1	1002	ARSENIC AS TOT UG/L	3/21/91	10
H1	1002	ARSENIC AS TOT UG/L	6/19/91	10
H1	1002	ARSENIC AS TOT UG/L	9/25/91	10
H1	1002	ARSENIC AS TOT UG/L	12/11/91	10
H1	1002	ARSENIC AS TOT UG/L	3/19/92	10
H1	1002	ARSENIC AS TOT UG/L	6/10/92	10
H1	1002	ARSENIC AS TOT UG/L	9/30/92	10
H1	1002	ARSENIC AS TOT UG/L	12/16/92	10
H1	1002	ARSENIC AS TOT UG/L	3/18/93	10
H1	1002	ARSENIC AS TOT UG/L	6/24/93	10
H1	1002	ARSENIC AS TOT UG/L	9/9/93	10
H1	1002	ARSENIC AS TOT UG/L	12/8/93	10
H1	1002	ARSENIC AS TOT UG/L	3/17/94	10
H1	1002	ARSENIC AS TOT UG/L	6/7/94	10
H1	1002	ARSENIC AS TOT UG/L	9/9/94	5
H1	1002	ARSENIC AS TOT UG/L	12/20/94	50
H1	1002	ARSENIC AS TOT UG/L	3/13/95	5
H1	1002	ARSENIC AS TOT UG/L	6/9/95	5
H1	1002	ARSENIC AS TOT UG/L	9/5/95	5
H1	1002	ARSENIC AS TOT UG/L	12/13/95	5
H1	1002	ARSENIC AS TOT UG/L	3/18/96	5
H1	1002	ARSENIC AS TOT UG/L	6/7/96	5
H1	1002	ARSENIC AS TOT UG/L	9/9/96	5
H1	1002	ARSENIC AS TOT UG/L	12/9/96	5
H1	1002	ARSENIC AS TOT UG/L	3/17/97	5
H1	1034	CHROMIUMCR TOT UG/L	6/3/81	5
H1	1034	CHROMIUMCR TOT UG/L	9/1/81	5
H1	1034	CHROMIUMCR TOT UG/L	6/3/82	5
H1	1034	CHROMIUMCR TOT UG/L	9/23/82	5
H1	1034	CHROMIUMCR TOT UG/L	12/14/83	50
H1	1034	CHROMIUMCR TOT UG/L	3/14/84	5
H1	1034	CHROMIUMCR TOT UG/L	6/21/84	5
H1	1034	CHROMIUMCR TOT UG/L	9/11/84	5
H1	1034	CHROMIUMCR TOT UG/L	12/5/84	5
H1	1034	CHROMIUMCR TOT UG/L	3/7/85	50
H1	1034	CHROMIUMCR TOT UG/L	6/14/85	5
H1	1034	CHROMIUMCR TOT UG/L	9/26/85	5
H1	1034	CHROMIUMCR TOT UG/L	12/11/85	5
H1	1034	CHROMIUMCR TOT UG/L	3/13/86	50
H1	1034	CHROMIUMCR TOT UG/L	6/5/86	5
H1	1034	CHROMIUMCR TOT UG/L	9/12/86	5
H1	1034	CHROMIUMCR TOT UG/L	12/3/86	5
H1	1034	CHROMIUMCR TOT UG/L	3/20/87	50
H1	1034	CHROMIUMCR TOT UG/L	6/11/87	5

Station	Parameter Code	Parameter Name	Date	Value
H1	1034	CHROMIUMCR TOT UG/L	9/9/87	5
H1	1034	CHROMIUMCR TOT UG/L	12/3/87	5
H1	1034	CHROMIUMCR TOT UG/L	3/10/88	25
H1	1034	CHROMIUMCR TOT UG/L	6/9/88	50
H1	1034	CHROMIUMCR TOT UG/L	9/27/88	50
H1	1034	CHROMIUMCR TOT UG/L	12/7/88	50
H1	1034	CHROMIUMCR TOT UG/L	3/15/89	50
H1	1034	CHROMIUMCR TOT UG/L	7/12/89	50
H1	1034	CHROMIUMCR TOT UG/L	9/21/89	50
H1	1034	CHROMIUMCR TOT UG/L	1/17/90	5
H1	1034	CHROMIUMCR TOT UG/L	3/14/90	5
H1	1034	CHROMIUMCR TOT UG/L	6/7/90	5
H1	1034	CHROMIUMCR TOT UG/L	9/26/90	5
H1	1034	CHROMIUMCR TOT UG/L	12/12/90	50
H1	1034	CHROMIUMCR TOT UG/L	3/21/91	50
H1	1034	CHROMIUMCR TOT UG/L	6/19/91	50
H1	1034	CHROMIUMCR TOT UG/L	9/25/91	50
H1	1034	CHROMIUMCR TOT UG/L	12/11/91	50
H1	1034	CHROMIUMCR TOT UG/L	3/19/92	50
H1	1034	CHROMIUMCR TOT UG/L	6/10/92	15
H1	1034	CHROMIUMCR TOT UG/L	9/30/92	15
H1	1034	CHROMIUMCR TOT UG/L	12/16/92	15
H1	1034	CHROMIUMCR TOT UG/L	3/18/93	15
H1	1034	CHROMIUMCR TOT UG/L	6/24/93	15
H1	1034	CHROMIUMCR TOT UG/L	9/9/93	15
H1	1034	CHROMIUMCR TOT UG/L	12/8/93	15
H1	1034	CHROMIUMCR TOT UG/L	3/17/94	15
H1	1034	CHROMIUMCR TOT UG/L	6/7/94	50
H1	1034	CHROMIUMCR TOT UG/L	9/9/94	50
H1	1034	CHROMIUMCR TOT UG/L	12/20/94	50
H1	1034	CHROMIUMCR TOT UG/L	3/13/95	50
H1	1034	CHROMIUMCR TOT UG/L	6/9/95	50
H1	1034	CHROMIUMCR TOT UG/L	9/5/95	50
H1	1034	CHROMIUMCR TOT UG/L	12/13/95	5
H1	1034	CHROMIUMCR TOT UG/L	3/18/96	5
H1	1034	CHROMIUMCR TOT UG/L	6/7/96	5
H1	1034	CHROMIUMCR TOT UG/L	9/9/96	5
H1	1034	CHROMIUMCR TOT UG/L	12/9/96	5
H1	1034	CHROMIUMCR TOT UG/L	3/17/97	5
H1	1042	COPPER CU TOT UG/L	6/3/81	14
H1	1042	COPPER CU TOT UG/L	9/1/81	49
H1	1042	COPPER CU TOT UG/L	6/3/82	9
H1	1042	COPPER CU TOT UG/L	9/23/82	5
H1	1042	COPPER CU TOT UG/L	3/14/84	5
H1	1042	COPPER CU TOT UG/L	6/21/84	5
H1	1042	COPPER CU TOT UG/L	9/11/84	5
H1	1042	COPPER CU TOT UG/L	12/5/84	5
H1	1042	COPPER CU TOT UG/L	3/7/85	50
H1	1042	COPPER CU TOT UG/L	6/14/85	9
H1	1042	COPPER CU TOT UG/L	9/26/85	5
H1	1042	COPPER CU TOT UG/L	12/11/85	5
H1	1042	COPPER CU TOT UG/L	3/13/86	80
H1	1042	COPPER CU TOT UG/L	6/5/86	5

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Station	Parameter Code	Parameter Name	Date	Value
H1	1042	COPPER CU TOT UG/L	9/12/86	7
H1	1042	COPPER CU TOT UG/L	12/3/86	5
H1	1042	COPPER CU TOT UG/L	3/20/87	50
H1	1042	COPPER CU TOT UG/L	6/11/87	5
H1	1042	COPPER CU TOT UG/L	9/9/87	5
H1	1042	COPPER CU TOT UG/L	12/3/87	5
H1	1042	COPPER CU TOT UG/L	3/10/88	25
H1	1042	COPPER CU TOT UG/L	9/27/88	50
H1	1042	COPPER CU TOT UG/L	12/7/88	50
H1	1042	COPPER CU TOT UG/L	7/12/89	50
H1	1042	COPPER CU TOT UG/L	9/21/89	50
H1	1042	COPPER CU TOT UG/L	1/17/90	50
H1	1042	COPPER CU TOT UG/L	3/14/90	50
H1	1042	COPPER CU TOT UG/L	6/7/90	50
H1	1042	COPPER CU TOT UG/L	9/26/90	50
H1	1042	COPPER CU TOT UG/L	12/12/90	50
H1	1042	COPPER CU TOT UG/L	3/21/91	50
H1	1042	COPPER CU TOT UG/L	6/19/91	50
H1	1042	COPPER CU TOT UG/L	9/25/91	50
H1	1042	COPPER CU TOT UG/L	12/11/91	50
H1	1042	COPPER CU TOT UG/L	3/19/92	50
H1	1042	COPPER CU TOT UG/L	6/10/92	20
H1	1042	COPPER CU TOT UG/L	9/30/92	20
H1	1042	COPPER CU TOT UG/L	12/16/92	20
H1	1042	COPPER CU TOT UG/L	3/18/93	20
H1	1042	COPPER CU TOT UG/L	6/24/93	20
H1	1042	COPPER CU TOT UG/L	9/9/93	20
H1	1042	COPPER CU TOT UG/L	12/8/93	20
H1	1042	COPPER CU TOT UG/L	3/17/94	20
H1	1042	COPPER CU TOT UG/L	6/7/94	50
H1	1042	COPPER CU TOT UG/L	9/9/94	50
H1	1042	COPPER CU TOT UG/L	12/20/94	50
H1	1042	COPPER CU TOT UG/L	3/13/95	50
H1	1042	COPPER CU TOT UG/L	6/9/95	50
H1	1042	COPPER CU TOT UG/L	9/5/95	50
H1	1042	COPPER CU TOT UG/L	12/13/95	50
H1	1042	COPPER CU TOT UG/L	3/18/96	5
H1	1042	COPPER CU TOT UG/L	6/7/96	50
H1	1042	COPPER CU TOT UG/L	9/9/96	50
H1	1042	COPPER CU TOT UG/L	12/9/96	50
H1	1042	COPPER CU TOT UG/L	3/17/97	50
H1	74010	IRON FE MG/L	3/1/74	1.3
H1	74010	IRON FE MG/L	6/1/74	0.5
H1	74010	IRON FE MG/L	9/1/74	0.5
H1	74010	IRON FE MG/L	12/1/74	1.8
H1	74010	IRON FE MG/L	6/23/75	1.26
H1	74010	IRON FE MG/L	10/16/75	0.25
H1	74010	IRON FE MG/L	9/7/76	0.5
H1	74010	IRON FE MG/L	1/6/77	1
H1	74010	IRON FE MG/L	4/7/77	2.35
H1	74010	IRON FE MG/L	7/6/77	0.33
H1	74010	IRON FE MG/L	9/7/78	0.1
H1	74010	IRON FE MG/L	6/3/82	0.157

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Station	Parameter Code	Parameter Name	Date	Value
H1	74010	IRON FE MG/L	9/23/82	0.07
H1	74010	IRON FE MG/L	12/14/83	2.8
H1	74010	IRON FE MG/L	3/14/84	0.05
H1	74010	IRON FE MG/L	6/21/84	0.08
H1	74010	IRON FE MG/L	9/11/84	0.15
H1	74010	IRON FE MG/L	12/5/84	1.9
H1	74010	IRON FE MG/L	3/7/85	0.9
H1	74010	IRON FE MG/L	6/14/85	0.4
H1	74010	IRON FE MG/L	9/26/85	0.21
H1	74010	IRON FE MG/L	12/11/85	0.67
H1	74010	IRON FE MG/L	3/13/86	11.3
H1	74010	IRON FE MG/L	6/5/86	0.56
H1	74010	IRON FE MG/L	9/12/86	6.16
H1	74010	IRON FE MG/L	12/3/86	1.19
H1	74010	IRON FE MG/L	3/20/87	1.3
H1	74010	IRON FE MG/L	6/11/87	0.35
H1	74010	IRON FE MG/L	9/9/87	0.22
H1	74010	IRON FE MG/L	12/3/87	0.384
H1	74010	IRON FE MG/L	3/10/88	2.3
H1	74010	IRON FE MG/L	6/9/88	0.3
H1	74010	IRON FE MG/L	9/27/88	0.58
H1	74010	IRON FE MG/L	12/7/88	0.63
H1	74010	IRON FE MG/L	3/15/89	0.87
H1	74010	IRON FE MG/L	7/12/89	0.75
H1	74010	IRON FE MG/L	9/21/89	0.41
H1	74010	IRON FE MG/L	1/17/90	1.14
H1	74010	IRON FE MG/L	3/14/90	1.17
H1	74010	IRON FE MG/L	6/7/90	0.46
H1	74010	IRON FE MG/L	9/26/90	0.15
H1	74010	IRON FE MG/L	12/12/90	0.41
H1	74010	IRON FE MG/L	3/21/91	0.7
H1	74010	IRON FE MG/L	6/19/91	0.32
H1	74010	IRON FE MG/L	9/25/91	7.83
H1	74010	IRON FE MG/L	12/11/91	0.57
H1	74010	IRON FE MG/L	3/19/92	6.87
H1	74010	IRON FE MG/L	6/10/92	1.22
H1	74010	IRON FE MG/L	9/30/92	0.71
H1	74010	IRON FE MG/L	12/16/92	4.84
H1	74010	IRON FE MG/L	3/18/93	0.345
H1	74010	IRON FE MG/L	6/24/93	0.32
H1	74010	IRON FE MG/L	9/9/93	0.539
H1	74010	IRON FE MG/L	12/8/93	0.534
H1	74010	IRON FE MG/L	3/17/94	0.781
H1	74010	IRON FE MG/L	6/7/94	0.6
H1	74010	IRON FE MG/L	9/9/94	0.3
H1	74010	IRON FE MG/L	12/20/94	1
H1	74010	IRON FE MG/L	3/13/95	1.1
H1	74010	IRON FE MG/L	6/9/95	0.6
H1	74010	IRON FE MG/L	9/5/95	0.1
H1	74010	IRON FE MG/L	12/13/95	0.7
H1	74010	IRON FE MG/L	3/18/96	0.5
H1	74010	IRON FE MG/L	6/7/96	0.3
H1	74010	IRON FE MG/L	9/9/96	0.4

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Station	Parameter Code	Parameter Name	Date	Value
H1	74010	IRON FE MG/L	12/9/96	0.7
H1	74010	IRON FE MG/L	3/17/97	0.9
H1	31613	FEC COLIM-FCAGAR /100ML	1/23/92	137
H1	31613	FEC COLIM-FCAGAR /100ML	2/20/92	178
H1	31613	FEC COLIM-FCAGAR /100ML	3/19/92	670
H1	31613	FEC COLIM-FCAGAR /100ML	4/15/92	50
H1	31613	FEC COLIM-FCAGAR /100ML	5/14/92	600
H1	31613	FEC COLIM-FCAGAR /100ML	6/10/92	13
H1	31613	FEC COLIM-FCAGAR /100ML	7/22/92	20
H1	31613	FEC COLIM-FCAGAR /100ML	9/3/92	600
H1	31613	FEC COLIM-FCAGAR /100ML	9/30/92	15
H1	31613	FEC COLIM-FCAGAR /100ML	11/5/92	200
H1	31613	FEC COLIM-FCAGAR /100ML	12/16/92	57
H1	31613	FEC COLIM-FCAGAR /100ML	1/21/93	230
H1	31613	FEC COLIM-FCAGAR /100ML	2/18/93	3
H1	31613	FEC COLIM-FCAGAR /100ML	3/18/93	43
H1	31613	FEC COLIM-FCAGAR /100ML	4/21/93	340
H1	31613	FEC COLIM-FCAGAR /100ML	5/19/93	350
H1	31613	FEC COLIM-FCAGAR /100ML	6/24/93	1
H1	31613	FEC COLIM-FCAGAR /100ML	7/21/93	1
H1	31613	FEC COLIM-FCAGAR /100ML	8/25/93	12
H1	31613	FEC COLIM-FCAGAR /100ML	9/9/93	60
H1	31613	FEC COLIM-FCAGAR /100ML	11/17/93	1067
H1	31613	FEC COLIM-FCAGAR /100ML	12/8/93	7
H1	31613	FEC COLIM-FCAGAR /100ML	1/20/94	10
H1	31613	FEC COLIM-FCAGAR /100ML	2/25/94	410
H1	31613	FEC COLIM-FCAGAR /100ML	3/17/94	23
H1	31613	FEC COLIM-FCAGAR /100ML	4/7/94	530
H1	31613	FEC COLIM-FCAGAR /100ML	9/9/94	0
H1	31613	FEC COLIM-FCAGAR /100ML	10/14/94	0
H1	31613	FEC COLIM-FCAGAR /100ML	6/9/97	620
H1	31613	FEC COLIM-FCAGAR /100ML	8/14/97	240
H1	31613	FEC COLIM-FCAGAR /100ML	8/20/98	80
H1	31613	FEC COLIM-FCAGAR /100ML	10/15/98	74
H1	515	RESIDUE DISS-105C MG/L	1/9/80	77
H1	515	RESIDUE DISS-105C MG/L	2/13/80	65
H1	515	RESIDUE DISS-105C MG/L	3/12/80	999.9
H1	515	RESIDUE DISS-105C MG/L	4/10/80	84
H1	515	RESIDUE DISS-105C MG/L	5/8/80	130
H1	515	RESIDUE DISS-105C MG/L	6/5/80	130
H1	515	RESIDUE DISS-105C MG/L	7/24/80	272
H1	515	RESIDUE DISS-105C MG/L	8/6/80	130
H1	515	RESIDUE DISS-105C MG/L	9/3/80	181
H1	515	RESIDUE DISS-105C MG/L	10/8/80	144
H1	515	RESIDUE DISS-105C MG/L	11/12/80	115
H1	515	RESIDUE DISS-105C MG/L	12/3/80	144
H1	515	RESIDUE DISS-105C MG/L	1/6/81	92
H1	515	RESIDUE DISS-105C MG/L	2/4/81	96
H1	515	RESIDUE DISS-105C MG/L	3/10/81	64
H1	515	RESIDUE DISS-105C MG/L	4/7/81	217
H1	515	RESIDUE DISS-105C MG/L	5/5/81	64
H1	515	RESIDUE DISS-105C MG/L	6/3/81	364
H1	515	RESIDUE DISS-105C MG/L	7/9/81	364

Station	Parameter Code	Parameter Name	Date	Value
H1	515	RESIDUE DISS-105C MG/L	8/6/81	164
H1	515	RESIDUE DISS-105C MG/L	9/1/81	160
H1	515	RESIDUE DISS-105C MG/L	10/8/81	171
H1	515	RESIDUE DISS-105C MG/L	11/3/81	145
H1	515	RESIDUE DISS-105C MG/L	12/2/81	99
H1	515	RESIDUE DISS-105C MG/L	1/20/82	115
H1	515	RESIDUE DISS-105C MG/L	2/2/82	306
H1	515	RESIDUE DISS-105C MG/L	3/3/82	92
H1	515	RESIDUE DISS-105C MG/L	4/7/82	65
H1	515	RESIDUE DISS-105C MG/L	5/13/82	112
H1	515	RESIDUE DISS-105C MG/L	6/3/82	112
H1	515	RESIDUE DISS-105C MG/L	7/8/82	227
H1	515	RESIDUE DISS-105C MG/L	8/25/82	262
H1	515	RESIDUE DISS-105C MG/L	9/23/82	289
H1	515	RESIDUE DISS-105C MG/L	10/26/82	212
H1	515	RESIDUE DISS-105C MG/L	11/16/82	153
H1	515	RESIDUE DISS-105C MG/L	12/14/82	55
H1	515	RESIDUE DISS-105C MG/L	1/11/83	112
H1	515	RESIDUE DISS-105C MG/L	2/3/83	68
H1	515	RESIDUE DISS-105C MG/L	3/9/83	71
H1	515	RESIDUE DISS-105C MG/L	4/20/83	85
H1	515	RESIDUE DISS-105C MG/L	5/4/83	128
H1	515	RESIDUE DISS-105C MG/L	6/16/83	183
H1	515	RESIDUE DISS-105C MG/L	7/14/83	175
H1	515	RESIDUE DISS-105C MG/L	8/4/83	176
H1	515	RESIDUE DISS-105C MG/L	9/8/83	83
H1	515	RESIDUE DISS-105C MG/L	10/20/83	201
H1	515	RESIDUE DISS-105C MG/L	11/16/83	150
H1	515	RESIDUE DISS-105C MG/L	12/14/83	125
H1	515	RESIDUE DISS-105C MG/L	1/19/84	104
H1	515	RESIDUE DISS-105C MG/L	2/16/84	52
H1	515	RESIDUE DISS-105C MG/L	3/14/84	100
H1	515	RESIDUE DISS-105C MG/L	4/18/84	93
H1	515	RESIDUE DISS-105C MG/L	5/9/84	101
H1	515	RESIDUE DISS-105C MG/L	6/21/84	276
H1	515	RESIDUE DISS-105C MG/L	7/18/84	268
H1	515	RESIDUE DISS-105C MG/L	8/9/84	180
H1	515	RESIDUE DISS-105C MG/L	9/11/84	275
H1	515	RESIDUE DISS-105C MG/L	10/4/84	267
H1	515	RESIDUE DISS-105C MG/L	11/15/84	195
H1	515	RESIDUE DISS-105C MG/L	12/5/84	147
H1	515	RESIDUE DISS-105C MG/L	1/17/85	146
H1	515	RESIDUE DISS-105C MG/L	2/6/85	73
H1	515	RESIDUE DISS-105C MG/L	3/7/85	147
H1	515	RESIDUE DISS-105C MG/L	4/4/85	147
H1	515	RESIDUE DISS-105C MG/L	5/3/85	185
H1	515	RESIDUE DISS-105C MG/L	6/14/85	240
H1	515	RESIDUE DISS-105C MG/L	7/10/85	202
H1	515	RESIDUE DISS-105C MG/L	8/14/85	248
H1	515	RESIDUE DISS-105C MG/L	9/26/85	167
H1	515	RESIDUE DISS-105C MG/L	10/10/85	190
H1	515	RESIDUE DISS-105C MG/L	11/13/85	242
H1	515	RESIDUE DISS-105C MG/L	12/11/85	106

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Station	Parameter Code	Parameter Name	Date	Value
H1	515	RESIDUE DISS-105C MG/L	1/16/86	126
H1	515	RESIDUE DISS-105C MG/L	2/6/86	115
H1	515	RESIDUE DISS-105C MG/L	3/13/86	563
H1	515	RESIDUE DISS-105C MG/L	4/17/86	123
H1	515	RESIDUE DISS-105C MG/L	5/15/86	539
H1	515	RESIDUE DISS-105C MG/L	6/5/86	151
H1	515	RESIDUE DISS-105C MG/L	7/23/86	185
H1	515	RESIDUE DISS-105C MG/L	8/7/86	204
H1	515	RESIDUE DISS-105C MG/L	9/12/86	203
H1	515	RESIDUE DISS-105C MG/L	10/17/86	183
H1	515	RESIDUE DISS-105C MG/L	11/6/86	291
H1	515	RESIDUE DISS-105C MG/L	12/3/86	84
H1	515	RESIDUE DISS-105C MG/L	1/15/87	123
H1	515	RESIDUE DISS-105C MG/L	2/19/87	83
H1	515	RESIDUE DISS-105C MG/L	3/20/87	75
H1	515	RESIDUE DISS-105C MG/L	4/16/87	125
H1	515	RESIDUE DISS-105C MG/L	5/14/87	127
H1	515	RESIDUE DISS-105C MG/L	6/11/87	214
H1	515	RESIDUE DISS-105C MG/L	7/10/87	172
H1	515	RESIDUE DISS-105C MG/L	8/7/87	317
H1	515	RESIDUE DISS-105C MG/L	9/9/87	428
H1	515	RESIDUE DISS-105C MG/L	10/22/87	367
H1	515	RESIDUE DISS-105C MG/L	11/6/87	352
H1	515	RESIDUE DISS-105C MG/L	12/3/87	215
H1	515	RESIDUE DISS-105C MG/L	1/14/88	140
H1	515	RESIDUE DISS-105C MG/L	2/11/88	122
H1	515	RESIDUE DISS-105C MG/L	3/10/88	66
H1	515	RESIDUE DISS-105C MG/L	4/21/88	99
H1	515	RESIDUE DISS-105C MG/L	5/18/88	206
H1	515	RESIDUE DISS-105C MG/L	6/9/88	227
H1	515	RESIDUE DISS-105C MG/L	7/7/88	284
H1	515	RESIDUE DISS-105C MG/L	8/17/88	222
H1	515	RESIDUE DISS-105C MG/L	9/27/88	142
H1	515	RESIDUE DISS-105C MG/L	10/12/88	255
H1	515	RESIDUE DISS-105C MG/L	11/9/88	147
H1	515	RESIDUE DISS-105C MG/L	12/7/88	122
H1	515	RESIDUE DISS-105C MG/L	1/18/89	61
H1	515	RESIDUE DISS-105C MG/L	2/22/89	46
H1	515	RESIDUE DISS-105C MG/L	3/15/89	124
H1	515	RESIDUE DISS-105C MG/L	4/19/89	121
H1	515	RESIDUE DISS-105C MG/L	5/11/89	136
H1	515	RESIDUE DISS-105C MG/L	7/12/89	133
H1	515	RESIDUE DISS-105C MG/L	8/16/89	268
H1	515	RESIDUE DISS-105C MG/L	9/21/89	234
H1	515	RESIDUE DISS-105C MG/L	10/25/89	214
H1	515	RESIDUE DISS-105C MG/L	11/29/89	140
H1	515	RESIDUE DISS-105C MG/L	1/17/90	124
H1	515	RESIDUE DISS-105C MG/L	3/14/90	100
H1	515	RESIDUE DISS-105C MG/L	4/12/90	148
H1	515	RESIDUE DISS-105C MG/L	5/9/90	217
H1	515	RESIDUE DISS-105C MG/L	6/7/90	348
H1	515	RESIDUE DISS-105C MG/L	7/18/90	285
H1	515	RESIDUE DISS-105C MG/L	8/30/90	268

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Station	Parameter Code	Parameter Name	Date	Value
H1	515	RESIDUE DISS-105C MG/L	9/26/90	278
H1	515	RESIDUE DISS-105C MG/L	10/24/90	230
H1	515	RESIDUE DISS-105C MG/L	11/28/90	181
H1	515	RESIDUE DISS-105C MG/L	12/12/90	187
H1	515	RESIDUE DISS-105C MG/L	1/24/91	129
H1	515	RESIDUE DISS-105C MG/L	2/21/91	38
H1	515	RESIDUE DISS-105C MG/L	3/21/91	156
H1	515	RESIDUE DISS-105C MG/L	5/16/91	97
H1	515	RESIDUE DISS-105C MG/L	6/19/91	233
H1	515	RESIDUE DISS-105C MG/L	7/24/91	191
H1	515	RESIDUE DISS-105C MG/L	8/15/91	220
H1	515	RESIDUE DISS-105C MG/L	9/25/91	215
H1	515	RESIDUE DISS-105C MG/L	10/30/91	211
H1	515	RESIDUE DISS-105C MG/L	11/21/91	91
H1	515	RESIDUE DISS-105C MG/L	12/11/91	232
H1	515	RESIDUE DISS-105C MG/L	1/23/92	92
H1	515	RESIDUE DISS-105C MG/L	2/20/92	62
H1	515	RESIDUE DISS-105C MG/L	3/19/92	115
H1	515	RESIDUE DISS-105C MG/L	4/15/92	110
H1	515	RESIDUE DISS-105C MG/L	5/14/92	163
H1	515	RESIDUE DISS-105C MG/L	6/10/92	179
H1	515	RESIDUE DISS-105C MG/L	7/22/92	198
H1	515	RESIDUE DISS-105C MG/L	9/3/92	151
H1	515	RESIDUE DISS-105C MG/L	9/30/92	136
H1	515	RESIDUE DISS-105C MG/L	11/5/92	55
H1	515	RESIDUE DISS-105C MG/L	12/16/92	70
H1	515	RESIDUE DISS-105C MG/L	1/21/93	60
H1	515	RESIDUE DISS-105C MG/L	2/18/93	51
H1	515	RESIDUE DISS-105C MG/L	3/18/93	68
H1	515	RESIDUE DISS-105C MG/L	4/21/93	164
H1	515	RESIDUE DISS-105C MG/L	5/19/93	94
H1	515	RESIDUE DISS-105C MG/L	6/24/93	346
H1	515	RESIDUE DISS-105C MG/L	7/21/93	408
H1	515	RESIDUE DISS-105C MG/L	8/25/93	81
H1	515	RESIDUE DISS-105C MG/L	9/9/93	296
H1	515	RESIDUE DISS-105C MG/L	11/17/93	122
H1	515	RESIDUE DISS-105C MG/L	12/8/93	162
H1	515	RESIDUE DISS-105C MG/L	1/20/94	118
H1	515	RESIDUE DISS-105C MG/L	2/25/94	73
H1	515	RESIDUE DISS-105C MG/L	3/17/94	1086
H1	515	RESIDUE DISS-105C MG/L	4/7/94	68
H1	515	RESIDUE DISS-105C MG/L	5/18/94	152
H1	515	RESIDUE DISS-105C MG/L	6/7/94	171
H1	515	RESIDUE DISS-105C MG/L	7/15/94	110
H1	515	RESIDUE DISS-105C MG/L	8/12/94	466
H1	515	RESIDUE DISS-105C MG/L	9/9/94	226
H1	515	RESIDUE DISS-105C MG/L	10/14/94	114
H1	515	RESIDUE DISS-105C MG/L	11/7/94	280
H1	515	RESIDUE DISS-105C MG/L	12/20/94	152
H1	515	RESIDUE DISS-105C MG/L	1/20/95	108
H1	515	RESIDUE DISS-105C MG/L	2/24/95	140
H1	515	RESIDUE DISS-105C MG/L	3/13/95	126
H1	515	RESIDUE DISS-105C MG/L	4/3/95	144

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Station	Parameter Code	Parameter Name	Date	Value
H1	515	RESIDUE DISS-105C MG/L	5/8/95	197
H1	515	RESIDUE DISS-105C MG/L	6/9/95	357
H1	515	RESIDUE DISS-105C MG/L	7/17/95	488
H1	515	RESIDUE DISS-105C MG/L	8/14/95	569
H1	515	RESIDUE DISS-105C MG/L	9/5/95	253
H1	515	RESIDUE DISS-105C MG/L	10/13/95	296
H1	515	RESIDUE DISS-105C MG/L	11/9/95	114
H1	515	RESIDUE DISS-105C MG/L	12/13/95	145
H1	515	RESIDUE DISS-105C MG/L	1/19/96	109
H1	515	RESIDUE DISS-105C MG/L	2/23/96	113
H1	515	RESIDUE DISS-105C MG/L	3/18/96	159
H1	515	RESIDUE DISS-105C MG/L	4/26/96	125
H1	515	RESIDUE DISS-105C MG/L	5/13/96	320
H1	515	RESIDUE DISS-105C MG/L	6/7/96	366
H1	515	RESIDUE DISS-105C MG/L	7/12/96	251
H1	515	RESIDUE DISS-105C MG/L	8/5/96	263
H1	515	RESIDUE DISS-105C MG/L	9/9/96	328
H1	515	RESIDUE DISS-105C MG/L	10/18/96	335
H1	515	RESIDUE DISS-105C MG/L	11/15/96	234
H1	515	RESIDUE DISS-105C MG/L	12/9/96	171
H1	515	RESIDUE DISS-105C MG/L	2/21/97	110
H1	515	RESIDUE DISS-105C MG/L	3/17/97	119
H1	515	RESIDUE DISS-105C MG/L	4/25/97	172
H1	515	RESIDUE DISS-105C MG/L	5/12/97	343
H1	515	RESIDUE DISS-105C MG/L	6/9/97	123
H1	515	RESIDUE DISS-105C MG/L	8/14/97	175
H1	515	RESIDUE DISS-105C MG/L	11/20/97	201
H1	515	RESIDUE DISS-105C MG/L	8/20/98	202
H1	515	RESIDUE DISS-105C MG/L	10/15/98	115
H1	530	RESIDUE TOT NFLT MG/L	1/9/80	9
H1	530	RESIDUE TOT NFLT MG/L	2/13/80	33
H1	530	RESIDUE TOT NFLT MG/L	3/12/80	851
H1	530	RESIDUE TOT NFLT MG/L	4/10/80	9
H1	530	RESIDUE TOT NFLT MG/L	5/8/80	11
H1	530	RESIDUE TOT NFLT MG/L	6/5/80	11
H1	530	RESIDUE TOT NFLT MG/L	7/24/80	9
H1	530	RESIDUE TOT NFLT MG/L	8/6/80	11
H1	530	RESIDUE TOT NFLT MG/L	9/3/80	7
H1	530	RESIDUE TOT NFLT MG/L	10/8/80	2
H1	530	RESIDUE TOT NFLT MG/L	11/12/80	21
H1	530	RESIDUE TOT NFLT MG/L	12/3/80	3
H1	530	RESIDUE TOT NFLT MG/L	1/6/81	10
H1	530	RESIDUE TOT NFLT MG/L	2/4/81	5
H1	530	RESIDUE TOT NFLT MG/L	3/10/81	9
H1	530	RESIDUE TOT NFLT MG/L	4/7/81	326
H1	530	RESIDUE TOT NFLT MG/L	5/5/81	5
H1	530	RESIDUE TOT NFLT MG/L	6/3/81	99
H1	530	RESIDUE TOT NFLT MG/L	7/9/81	20
H1	530	RESIDUE TOT NFLT MG/L	8/6/81	18
H1	530	RESIDUE TOT NFLT MG/L	9/1/81	11
H1	530	RESIDUE TOT NFLT MG/L	10/8/81	9
H1	530	RESIDUE TOT NFLT MG/L	11/3/81	1
H1	530	RESIDUE TOT NFLT MG/L	12/2/81	27

Station	Parameter Code	Parameter Name	Date	Value
H1	530	RESIDUE TOT NFLT MG/L	1/20/82	18
H1	530	RESIDUE TOT NFLT MG/L	2/2/82	220
H1	530	RESIDUE TOT NFLT MG/L	3/3/82	8
H1	530	RESIDUE TOT NFLT MG/L	4/7/82	12
H1	530	RESIDUE TOT NFLT MG/L	5/13/82	9
H1	530	RESIDUE TOT NFLT MG/L	6/3/82	8
H1	530	RESIDUE TOT NFLT MG/L	7/8/82	5
H1	530	RESIDUE TOT NFLT MG/L	8/25/82	3
H1	530	RESIDUE TOT NFLT MG/L	9/23/82	1
H1	530	RESIDUE TOT NFLT MG/L	10/26/82	3
H1	530	RESIDUE TOT NFLT MG/L	11/16/82	1
H1	530	RESIDUE TOT NFLT MG/L	12/14/82	25
H1	530	RESIDUE TOT NFLT MG/L	1/11/83	23
H1	530	RESIDUE TOT NFLT MG/L	2/3/83	48
H1	530	RESIDUE TOT NFLT MG/L	3/9/83	13
H1	530	RESIDUE TOT NFLT MG/L	4/20/83	10
H1	530	RESIDUE TOT NFLT MG/L	5/4/83	10
H1	530	RESIDUE TOT NFLT MG/L	6/16/83	82
H1	530	RESIDUE TOT NFLT MG/L	7/14/83	7
H1	530	RESIDUE TOT NFLT MG/L	8/4/83	2
H1	530	RESIDUE TOT NFLT MG/L	9/8/83	9
H1	530	RESIDUE TOT NFLT MG/L	10/20/83	1
H1	530	RESIDUE TOT NFLT MG/L	11/16/83	20
H1	530	RESIDUE TOT NFLT MG/L	12/14/83	104
H1	530	RESIDUE TOT NFLT MG/L	1/19/84	74
H1	530	RESIDUE TOT NFLT MG/L	2/16/84	10
H1	530	RESIDUE TOT NFLT MG/L	3/14/84	11
H1	530	RESIDUE TOT NFLT MG/L	4/18/84	17
H1	530	RESIDUE TOT NFLT MG/L	5/9/84	37
H1	530	RESIDUE TOT NFLT MG/L	6/21/84	3
H1	530	RESIDUE TOT NFLT MG/L	7/18/84	2
H1	530	RESIDUE TOT NFLT MG/L	8/9/84	6
H1	530	RESIDUE TOT NFLT MG/L	9/11/84	3
H1	530	RESIDUE TOT NFLT MG/L	10/4/84	1
H1	530	RESIDUE TOT NFLT MG/L	11/15/84	3
H1	530	RESIDUE TOT NFLT MG/L	12/5/84	79
H1	530	RESIDUE TOT NFLT MG/L	1/17/85	56
H1	530	RESIDUE TOT NFLT MG/L	2/6/85	148
H1	530	RESIDUE TOT NFLT MG/L	3/7/85	8
H1	530	RESIDUE TOT NFLT MG/L	4/4/85	4
H1	530	RESIDUE TOT NFLT MG/L	5/3/85	103
H1	530	RESIDUE TOT NFLT MG/L	6/14/85	6
H1	530	RESIDUE TOT NFLT MG/L	7/10/85	3
H1	530	RESIDUE TOT NFLT MG/L	8/14/85	3
H1	530	RESIDUE TOT NFLT MG/L	9/26/85	6
H1	530	RESIDUE TOT NFLT MG/L	10/10/85	5
H1	530	RESIDUE TOT NFLT MG/L	11/13/85	49
H1	530	RESIDUE TOT NFLT MG/L	12/11/85	28
H1	530	RESIDUE TOT NFLT MG/L	1/16/86	12
H1	530	RESIDUE TOT NFLT MG/L	2/6/86	50
H1	530	RESIDUE TOT NFLT MG/L	3/13/86	405
H1	530	RESIDUE TOT NFLT MG/L	4/17/86	4
H1	530	RESIDUE TOT NFLT MG/L	5/15/86	2

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Station	Parameter Code	Parameter Name	Date	Value
H1	530	RESIDUE TOT NFLT MG/L	6/5/86	10
H1	530	RESIDUE TOT NFLT MG/L	6/7/86	1
H1	530	RESIDUE TOT NFLT MG/L	7/23/86	4
H1	530	RESIDUE TOT NFLT MG/L	8/7/86	20
H1	530	RESIDUE TOT NFLT MG/L	9/12/86	159
H1	530	RESIDUE TOT NFLT MG/L	10/17/86	9
H1	530	RESIDUE TOT NFLT MG/L	11/6/86	12
H1	530	RESIDUE TOT NFLT MG/L	12/3/86	8
H1	530	RESIDUE TOT NFLT MG/L	1/15/87	6
H1	530	RESIDUE TOT NFLT MG/L	2/19/87	13
H1	530	RESIDUE TOT NFLT MG/L	3/20/87	26
H1	530	RESIDUE TOT NFLT MG/L	4/16/87	4
H1	530	RESIDUE TOT NFLT MG/L	5/14/87	42
H1	530	RESIDUE TOT NFLT MG/L	6/11/87	2
H1	530	RESIDUE TOT NFLT MG/L	7/10/87	0
H1	530	RESIDUE TOT NFLT MG/L	8/7/87	4
H1	530	RESIDUE TOT NFLT MG/L	9/9/87	4
H1	530	RESIDUE TOT NFLT MG/L	10/22/87	2
H1	530	RESIDUE TOT NFLT MG/L	11/6/87	1
H1	530	RESIDUE TOT NFLT MG/L	12/3/87	1
H1	530	RESIDUE TOT NFLT MG/L	1/14/88	1
H1	530	RESIDUE TOT NFLT MG/L	2/11/88	8
H1	530	RESIDUE TOT NFLT MG/L	3/10/88	35
H1	530	RESIDUE TOT NFLT MG/L	4/21/88	17
H1	530	RESIDUE TOT NFLT MG/L	5/18/88	2
H1	530	RESIDUE TOT NFLT MG/L	6/9/88	5
H1	530	RESIDUE TOT NFLT MG/L	7/7/88	7
H1	530	RESIDUE TOT NFLT MG/L	8/17/88	1
H1	530	RESIDUE TOT NFLT MG/L	9/27/88	4
H1	530	RESIDUE TOT NFLT MG/L	10/12/88	5
H1	530	RESIDUE TOT NFLT MG/L	11/9/88	5
H1	530	RESIDUE TOT NFLT MG/L	12/7/88	3
H1	530	RESIDUE TOT NFLT MG/L	1/18/89	16
H1	530	RESIDUE TOT NFLT MG/L	2/22/89	40
H1	530	RESIDUE TOT NFLT MG/L	3/15/89	24
H1	530	RESIDUE TOT NFLT MG/L	4/19/89	5
H1	530	RESIDUE TOT NFLT MG/L	5/11/89	13
H1	530	RESIDUE TOT NFLT MG/L	7/12/89	4
H1	530	RESIDUE TOT NFLT MG/L	8/16/89	1
H1	530	RESIDUE TOT NFLT MG/L	9/21/89	13
H1	530	RESIDUE TOT NFLT MG/L	10/25/89	2
H1	530	RESIDUE TOT NFLT MG/L	11/29/89	11
H1	530	RESIDUE TOT NFLT MG/L	1/17/90	6
H1	530	RESIDUE TOT NFLT MG/L	3/14/90	10
H1	530	RESIDUE TOT NFLT MG/L	4/12/90	10
H1	530	RESIDUE TOT NFLT MG/L	5/9/90	55
H1	530	RESIDUE TOT NFLT MG/L	6/7/90	1
H1	530	RESIDUE TOT NFLT MG/L	7/18/90	25
H1	530	RESIDUE TOT NFLT MG/L	8/30/90	11
H1	530	RESIDUE TOT NFLT MG/L	9/26/90	3
H1	530	RESIDUE TOT NFLT MG/L	10/24/90	1
H1	530	RESIDUE TOT NFLT MG/L	11/28/90	72
H1	530	RESIDUE TOT NFLT MG/L	12/12/90	1

Station	Parameter Code	Parameter Name	Date	Value
H1	530	RESIDUE TOT NFLT MG/L	1/24/91	4
H1	530	RESIDUE TOT NFLT MG/L	2/21/91	73
H1	530	RESIDUE TOT NFLT MG/L	3/21/91	4
H1	530	RESIDUE TOT NFLT MG/L	5/16/91	47
H1	530	RESIDUE TOT NFLT MG/L	6/19/91	1
H1	530	RESIDUE TOT NFLT MG/L	7/24/91	1
H1	530	RESIDUE TOT NFLT MG/L	8/15/91	1
H1	530	RESIDUE TOT NFLT MG/L	9/25/91	290
H1	530	RESIDUE TOT NFLT MG/L	10/30/91	2
H1	530	RESIDUE TOT NFLT MG/L	11/21/91	149
H1	530	RESIDUE TOT NFLT MG/L	12/11/91	3
H1	530	RESIDUE TOT NFLT MG/L	1/23/92	418
H1	530	RESIDUE TOT NFLT MG/L	2/20/92	12
H1	530	RESIDUE TOT NFLT MG/L	3/19/92	118
H1	530	RESIDUE TOT NFLT MG/L	4/15/92	7
H1	530	RESIDUE TOT NFLT MG/L	5/14/92	38
H1	530	RESIDUE TOT NFLT MG/L	6/10/92	17
H1	530	RESIDUE TOT NFLT MG/L	7/22/92	2
H1	530	RESIDUE TOT NFLT MG/L	9/3/92	1133
H1	530	RESIDUE TOT NFLT MG/L	9/30/92	3
H1	530	RESIDUE TOT NFLT MG/L	11/5/92	82
H1	530	RESIDUE TOT NFLT MG/L	12/16/92	134
H1	530	RESIDUE TOT NFLT MG/L	1/21/93	226
H1	530	RESIDUE TOT NFLT MG/L	2/18/93	9
H1	530	RESIDUE TOT NFLT MG/L	3/18/93	31
H1	530	RESIDUE TOT NFLT MG/L	4/21/93	141
H1	530	RESIDUE TOT NFLT MG/L	5/19/93	34
H1	530	RESIDUE TOT NFLT MG/L	6/24/93	4
H1	530	RESIDUE TOT NFLT MG/L	7/21/93	1
H1	530	RESIDUE TOT NFLT MG/L	8/25/93	1
H1	530	RESIDUE TOT NFLT MG/L	9/9/93	7
H1	530	RESIDUE TOT NFLT MG/L	11/17/93	591
H1	530	RESIDUE TOT NFLT MG/L	12/8/93	1
H1	530	RESIDUE TOT NFLT MG/L	1/20/94	6
H1	530	RESIDUE TOT NFLT MG/L	2/25/94	22
H1	530	RESIDUE TOT NFLT MG/L	3/17/94	2
H1	530	RESIDUE TOT NFLT MG/L	4/7/94	67
H1	530	RESIDUE TOT NFLT MG/L	5/18/94	2
H1	530	RESIDUE TOT NFLT MG/L	6/7/94	5
H1	530	RESIDUE TOT NFLT MG/L	7/15/94	80
H1	530	RESIDUE TOT NFLT MG/L	8/12/94	2
H1	530	RESIDUE TOT NFLT MG/L	9/9/94	1
H1	530	RESIDUE TOT NFLT MG/L	10/14/94	23
H1	530	RESIDUE TOT NFLT MG/L	11/7/94	4
H1	530	RESIDUE TOT NFLT MG/L	12/20/94	6
H1	530	RESIDUE TOT NFLT MG/L	1/20/95	31
H1	530	RESIDUE TOT NFLT MG/L	2/24/95	10
H1	530	RESIDUE TOT NFLT MG/L	3/13/95	8
H1	530	RESIDUE TOT NFLT MG/L	4/3/95	5
H1	530	RESIDUE TOT NFLT MG/L	5/8/95	2
H1	530	RESIDUE TOT NFLT MG/L	6/9/95	2
H1	530	RESIDUE TOT NFLT MG/L	7/17/95	8
H1	530	RESIDUE TOT NFLT MG/L	8/14/95	1

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Station	Parameter Code	Parameter Name	Date	Value
H1	530	RESIDUE TOT NFLT MG/L	9/5/95	2
H1	530	RESIDUE TOT NFLT MG/L	10/13/95	1
H1	530	RESIDUE TOT NFLT MG/L	11/9/95	29
H1	530	RESIDUE TOT NFLT MG/L	12/13/95	3
H1	530	RESIDUE TOT NFLT MG/L	1/19/96	52
H1	530	RESIDUE TOT NFLT MG/L	2/23/96	7
H1	530	RESIDUE TOT NFLT MG/L	3/18/96	5
H1	530	RESIDUE TOT NFLT MG/L	4/26/96	6
H1	530	RESIDUE TOT NFLT MG/L	5/13/96	1
H1	530	RESIDUE TOT NFLT MG/L	6/7/96	1
H1	530	RESIDUE TOT NFLT MG/L	7/12/96	7
H1	530	RESIDUE TOT NFLT MG/L	8/5/96	3
H1	530	RESIDUE TOT NFLT MG/L	9/9/96	3
H1	530	RESIDUE TOT NFLT MG/L	10/18/96	5
H1	530	RESIDUE TOT NFLT MG/L	11/15/96	4
H1	530	RESIDUE TOT NFLT MG/L	12/9/96	3
H1	530	RESIDUE TOT NFLT MG/L	2/21/97	375
H1	530	RESIDUE TOT NFLT MG/L	3/17/97	8
H1	530	RESIDUE TOT NFLT MG/L	4/25/97	4
H1	530	RESIDUE TOT NFLT MG/L	5/12/97	1
H1	530	RESIDUE TOT NFLT MG/L	6/9/97	3
H1	530	RESIDUE TOT NFLT MG/L	8/14/97	2
H1	530	RESIDUE TOT NFLT MG/L	11/20/97	1
H1	530	RESIDUE TOT NFLT MG/L	8/20/98	1
H1	530	RESIDUE TOT NFLT MG/L	10/15/98	3
H1	82079	TURBIDTY LAB NTU	1/9/80	7.1
H1	82079	TURBIDTY LAB NTU	2/13/80	7
H1	82079	TURBIDTY LAB NTU	3/12/80	180
H1	82079	TURBIDTY LAB NTU	4/10/80	1
H1	82079	TURBIDTY LAB NTU	5/8/80	2
H1	82079	TURBIDTY LAB NTU	6/5/80	0
H1	82079	TURBIDTY LAB NTU	7/24/80	0
H1	82079	TURBIDTY LAB NTU	8/6/80	0
H1	82079	TURBIDTY LAB NTU	9/3/80	2
H1	82079	TURBIDTY LAB NTU	10/8/80	2
H1	82079	TURBIDTY LAB NTU	11/12/80	2
H1	82079	TURBIDTY LAB NTU	12/3/80	4
H1	82079	TURBIDTY LAB NTU	1/6/81	3
H1	82079	TURBIDTY LAB NTU	2/4/81	9
H1	82079	TURBIDTY LAB NTU	3/10/81	3
H1	82079	TURBIDTY LAB NTU	4/7/81	51
H1	82079	TURBIDTY LAB NTU	5/5/81	2
H1	82079	TURBIDTY LAB NTU	6/3/81	38
H1	82079	TURBIDTY LAB NTU	7/9/81	3
H1	82079	TURBIDTY LAB NTU	9/1/81	6.9
H1	82079	TURBIDTY LAB NTU	10/8/81	3.2
H1	82079	TURBIDTY LAB NTU	11/3/81	2.7
H1	82079	TURBIDTY LAB NTU	12/2/81	22
H1	82079	TURBIDTY LAB NTU	1/20/82	12
H1	82079	TURBIDTY LAB NTU	2/2/82	75
H1	82079	TURBIDTY LAB NTU	3/3/82	11
H1	82079	TURBIDTY LAB NTU	4/7/82	21
H1	82079	TURBIDTY LAB NTU	5/13/82	10

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Station	Parameter Code	Parameter Name	Date	Value
H1	82079	TURBIDTY LAB NTU	6/3/82	6
H1	82079	TURBIDTY LAB NTU	7/8/82	2.5
H1	82079	TURBIDTY LAB NTU	8/25/82	0.7
H1	82079	TURBIDTY LAB NTU	9/23/82	0.7
H1	82079	TURBIDTY LAB NTU	10/26/82	3.2
H1	82079	TURBIDTY LAB NTU	11/16/82	3.5
H1	82079	TURBIDTY LAB NTU	12/14/82	16
H1	82079	TURBIDTY LAB NTU	1/11/83	20
H1	82079	TURBIDTY LAB NTU	2/3/83	40
H1	82079	TURBIDTY LAB NTU	3/9/83	30
H1	82079	TURBIDTY LAB NTU	4/20/83	10
H1	82079	TURBIDTY LAB NTU	5/4/83	12
H1	82079	TURBIDTY LAB NTU	6/16/83	80
H1	82079	TURBIDTY LAB NTU	7/14/83	4
H1	82079	TURBIDTY LAB NTU	8/4/83	4
H1	82079	TURBIDTY LAB NTU	9/8/83	7
H1	82079	TURBIDTY LAB NTU	10/20/83	1.5
H1	82079	TURBIDTY LAB NTU	11/16/83	10
H1	82079	TURBIDTY LAB NTU	12/14/83	73
H1	82079	TURBIDTY LAB NTU	1/19/84	43
H1	82079	TURBIDTY LAB NTU	2/16/84	17
H1	82079	TURBIDTY LAB NTU	3/14/84	8.6
H1	82079	TURBIDTY LAB NTU	4/18/84	12
H1	82079	TURBIDTY LAB NTU	5/9/84	32
H1	82079	TURBIDTY LAB NTU	6/21/84	1
H1	82079	TURBIDTY LAB NTU	7/18/84	0
H1	82079	TURBIDTY LAB NTU	8/9/84	18
H1	82079	TURBIDTY LAB NTU	9/11/84	2
H1	82079	TURBIDTY LAB NTU	10/4/84	1
H1	82079	TURBIDTY LAB NTU	11/15/84	2
H1	82079	TURBIDTY LAB NTU	12/5/84	29
H1	82079	TURBIDTY LAB NTU	1/17/85	6
H1	82079	TURBIDTY LAB NTU	2/6/85	61
H1	82079	TURBIDTY LAB NTU	3/7/85	5
H1	82079	TURBIDTY LAB NTU	4/4/85	2
H1	82079	TURBIDTY LAB NTU	5/3/85	42
H1	82079	TURBIDTY LAB NTU	6/14/85	1
H1	82079	TURBIDTY LAB NTU	7/10/85	5
H1	82079	TURBIDTY LAB NTU	8/14/85	2
H1	82079	TURBIDTY LAB NTU	9/26/85	2
H1	82079	TURBIDTY LAB NTU	10/10/85	8
H1	82079	TURBIDTY LAB NTU	11/13/85	2
H1	82079	TURBIDTY LAB NTU	12/11/85	7.6
H1	82079	TURBIDTY LAB NTU	1/16/86	4
H1	82079	TURBIDTY LAB NTU	2/6/86	40
H1	82079	TURBIDTY LAB NTU	3/13/86	195
H1	82079	TURBIDTY LAB NTU	4/17/86	9
H1	82079	TURBIDTY LAB NTU	5/15/86	7.5
H1	82079	TURBIDTY LAB NTU	6/5/86	5
H1	82079	TURBIDTY LAB NTU	7/23/86	3
H1	82079	TURBIDTY LAB NTU	8/7/86	25
H1	82079	TURBIDTY LAB NTU	9/12/86	96
H1	82079	TURBIDTY LAB NTU	10/17/86	8

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Station	Parameter Code	Parameter Name	Date	Value
H1	82079	TURBIDITY LAB NTU	11/6/86	1.4
H1	82079	TURBIDITY LAB NTU	12/3/86	45
H1	82079	TURBIDITY LAB NTU	1/15/87	11
H1	82079	TURBIDITY LAB NTU	2/19/87	38
H1	82079	TURBIDITY LAB NTU	3/20/87	7.7
H1	82079	TURBIDITY LAB NTU	4/16/87	5.6
H1	82079	TURBIDITY LAB NTU	5/14/87	140
H1	82079	TURBIDITY LAB NTU	6/11/87	9.1
H1	82079	TURBIDITY LAB NTU	7/10/87	7.5
H1	82079	TURBIDITY LAB NTU	8/7/87	5.5
H1	82079	TURBIDITY LAB NTU	9/9/87	3
H1	82079	TURBIDITY LAB NTU	10/22/87	7.6
H1	82079	TURBIDITY LAB NTU	11/6/87	2.5
H1	82079	TURBIDITY LAB NTU	12/3/87	2
H1	82079	TURBIDITY LAB NTU	1/14/88	9
H1	82079	TURBIDITY LAB NTU	2/11/88	10
H1	82079	TURBIDITY LAB NTU	3/10/88	27
H1	82079	TURBIDITY LAB NTU	4/21/88	22
H1	82079	TURBIDITY LAB NTU	5/18/88	1
H1	82079	TURBIDITY LAB NTU	7/7/88	8.5
H1	82079	TURBIDITY LAB NTU	8/17/88	3.6
H1	82079	TURBIDITY LAB NTU	9/27/88	8
H1	82079	TURBIDITY LAB NTU	10/12/88	9
H1	82079	TURBIDITY LAB NTU	11/9/88	9
H1	82079	TURBIDITY LAB NTU	12/7/88	6
H1	82079	TURBIDITY LAB NTU	1/17/89	10
H1	82079	TURBIDITY LAB NTU	1/18/89	23
H1	82079	TURBIDITY LAB NTU	2/22/89	61
H1	82079	TURBIDITY LAB NTU	3/15/89	22
H1	82079	TURBIDITY LAB NTU	4/19/89	19
H1	82079	TURBIDITY LAB NTU	5/11/89	15
H1	82079	TURBIDITY LAB NTU	7/12/89	13
H1	82079	TURBIDITY LAB NTU	8/16/89	4
H1	82079	TURBIDITY LAB NTU	9/21/89	12
H1	82079	TURBIDITY LAB NTU	10/25/89	7
H1	82079	TURBIDITY LAB NTU	11/29/89	19
H1	82079	TURBIDITY LAB NTU	3/14/90	10
H1	82079	TURBIDITY LAB NTU	4/12/90	15
H1	82079	TURBIDITY LAB NTU	5/9/90	48
H1	82079	TURBIDITY LAB NTU	6/7/90	6
H1	82079	TURBIDITY LAB NTU	7/18/90	41
H1	82079	TURBIDITY LAB NTU	8/30/90	14
H1	82079	TURBIDITY LAB NTU	9/26/90	2.5
H1	82079	TURBIDITY LAB NTU	10/24/90	5
H1	82079	TURBIDITY LAB NTU	11/28/90	72
H1	82079	TURBIDITY LAB NTU	12/12/90	8.5
H1	82079	TURBIDITY LAB NTU	1/24/91	16
H1	82079	TURBIDITY LAB NTU	2/21/91	79
H1	82079	TURBIDITY LAB NTU	3/21/91	12.5
H1	82079	TURBIDITY LAB NTU	5/16/91	49
H1	82079	TURBIDITY LAB NTU	6/19/91	4.7
H1	82079	TURBIDITY LAB NTU	7/24/91	9
H1	82079	TURBIDITY LAB NTU	8/15/91	7

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Station	Parameter Code	Parameter Name	Date	Value
H1	82079	TURBIDTY LAB NTU	9/25/91	100
H1	82079	TURBIDTY LAB NTU	10/30/91	5
H1	82079	TURBIDTY LAB NTU	11/21/91	100
H1	82079	TURBIDTY LAB NTU	12/11/91	13
H1	82079	TURBIDTY LAB NTU	1/23/92	100
H1	82079	TURBIDTY LAB NTU	2/20/92	21
H1	82079	TURBIDTY LAB NTU	3/19/92	100
H1	82079	TURBIDTY LAB NTU	4/15/92	12
H1	82079	TURBIDTY LAB NTU	5/14/92	45.5
H1	82079	TURBIDTY LAB NTU	6/10/92	25
H1	82079	TURBIDTY LAB NTU	7/22/92	7
H1	82079	TURBIDTY LAB NTU	9/3/92	100
H1	82079	TURBIDTY LAB NTU	9/30/92	5.6
H1	82079	TURBIDTY LAB NTU	11/5/92	86
H1	82079	TURBIDTY LAB NTU	12/16/92	100
H1	82079	TURBIDTY LAB NTU	1/21/93	100
H1	82079	TURBIDTY LAB NTU	2/18/93	22
H1	82079	TURBIDTY LAB NTU	3/18/93	38
H1	82079	TURBIDTY LAB NTU	4/21/93	100
H1	82079	TURBIDTY LAB NTU	5/19/93	55
H1	82079	TURBIDTY LAB NTU	6/24/93	3.2
H1	82079	TURBIDTY LAB NTU	7/21/93	1.6
H1	82079	TURBIDTY LAB NTU	8/25/93	6.7
H1	82079	TURBIDTY LAB NTU	9/9/93	11
H1	82079	TURBIDTY LAB NTU	11/17/93	100
H1	82079	TURBIDTY LAB NTU	12/8/93	2.6
H1	82079	TURBIDTY LAB NTU	1/20/94	15
H1	82079	TURBIDTY LAB NTU	2/25/94	39
H1	82079	TURBIDTY LAB NTU	3/17/94	10
H1	82079	TURBIDTY LAB NTU	4/7/94	69
H1	82079	TURBIDTY LAB NTU	5/18/94	8.1
H1	82079	TURBIDTY LAB NTU	6/7/94	16.1
H1	82079	TURBIDTY LAB NTU	7/15/94	116
H1	82079	TURBIDTY LAB NTU	8/12/94	5.4
H1	82079	TURBIDTY LAB NTU	9/9/94	3.5
H1	82079	TURBIDTY LAB NTU	10/14/94	63
H1	82079	TURBIDTY LAB NTU	11/7/94	17.9
H1	82079	TURBIDTY LAB NTU	12/20/94	11.5
H1	82079	TURBIDTY LAB NTU	1/20/95	47
H1	82079	TURBIDTY LAB NTU	2/24/95	13.1
H1	82079	TURBIDTY LAB NTU	3/13/95	15.2
H1	82079	TURBIDTY LAB NTU	4/3/95	8.6
H1	82079	TURBIDTY LAB NTU	5/8/95	9.8
H1	82079	TURBIDTY LAB NTU	6/9/95	5.8
H1	82079	TURBIDTY LAB NTU	7/17/95	4.2
H1	82079	TURBIDTY LAB NTU	8/14/95	2
H1	82079	TURBIDTY LAB NTU	9/5/95	1.7
H1	82079	TURBIDTY LAB NTU	10/13/95	2.8
H1	82079	TURBIDTY LAB NTU	11/9/95	43
H1	82079	TURBIDTY LAB NTU	12/13/95	59
H1	82079	TURBIDTY LAB NTU	1/19/96	55
H1	82079	TURBIDTY LAB NTU	2/23/96	12.1
H1	82079	TURBIDTY LAB NTU	3/18/96	8.4

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Station	Parameter Code	Parameter Name	Date	Value
H1	82079	TURBIDITY LAB NTU	4/26/96	11.5
H1	82079	TURBIDITY LAB NTU	5/13/96	3.7
H1	82079	TURBIDITY LAB NTU	6/7/96	5.2
H1	82079	TURBIDITY LAB NTU	7/12/96	21
H1	82079	TURBIDITY LAB NTU	8/5/96	6.8
H1	82079	TURBIDITY LAB NTU	9/9/96	7.1
H1	82079	TURBIDITY LAB NTU	10/18/96	11.4
H1	82079	TURBIDITY LAB NTU	11/15/96	8.2
H1	82079	TURBIDITY LAB NTU	12/9/96	7.9
H1	82079	TURBIDITY LAB NTU	2/21/97	312
H1	82079	TURBIDITY LAB NTU	3/17/97	14.2
H1	82079	TURBIDITY LAB NTU	4/25/97	13.2
H1	82079	TURBIDITY LAB NTU	5/12/97	3.6
H1	82079	TURBIDITY LAB NTU	6/9/97	17
H1	82079	TURBIDITY LAB NTU	8/14/97	6.6
H1	82079	TURBIDITY LAB NTU	11/20/97	3.9
H1	82079	TURBIDITY LAB NTU	8/20/98	7.6
H1	82079	TURBIDITY LAB NTU	10/15/98	5.4
LHCT-2A	82079	Field Turbidity, NTU	6/11/96	120
LHCT-2A	82079	Field Turbidity, NTU	6/12/96	66
LHCT-2A	82079	Field Turbidity, NTU	8/27/96	49.2
LHCT-2A	82079	Field Turbidity, NTU	8/28/96	1000
LHCT-2B	82079	Field Turbidity, NTU	6/11/96	121
LHCT-2B	82079	Field Turbidity, NTU	6/12/96	70
LHCT-2B	82079	Field Turbidity, NTU	8/27/96	46.7
LHCT-2B	82079	Field Turbidity, NTU	8/28/96	1000
HCRT-1	82079	Field Turbidity, NTU	6/11/96	33
HCRT-1	82079	Field Turbidity, NTU	6/12/96	20
HCRT-1	82079	Field Turbidity, NTU	8/27/96	28.0
HCRT-1	82079	Field Turbidity, NTU	8/28/96	33.9
NFHT-1	82079	Field Turbidity, NTU	8/27/96	7.0
NFHT-1	82079	Field Turbidity, NTU	8/28/96	5.9
HCRT-2	82079	Field Turbidity, NTU	6/11/96	7.8
HCRT-2	82079	Field Turbidity, NTU	6/12/96	19
HCRT-2	82079	Field Turbidity, NTU	8/27/96	9.7
HCRT-2	82079	Field Turbidity, NTU	8/28/96	12.7
HCRT-3	82079	Field Turbidity, NTU	6/11/96	76
HCRT-3	82079	Field Turbidity, NTU	6/12/96	49
HCRT-3	82079	Field Turbidity, NTU	8/27/96	24.6
HCRT-3	82079	Field Turbidity, NTU	8/28/96	40.2
HCRT-4	82079	Field Turbidity, NTU	6/11/96	3.3
HCRT-4	82079	Field Turbidity, NTU	6/12/96	5.6
HCRT-4	82079	Field Turbidity, NTU	8/27/96	32.4
HCRT-4	82079	Field Turbidity, NTU	8/28/96	47.9
H-1	82079	Field Turbidity, NTU	6/11/96	3.9
H-1	82079	Field Turbidity, NTU	6/12/96	6.4
H-1	82079	Field Turbidity, NTU	8/27/96	60.7
H-1	82079	Field Turbidity, NTU	8/28/96	41.3
LHCT-2A	31613	Fecal coliform, col/ml	6/12/96	174
LHCT-2A	31613	Fecal coliform, col/ml	8/28/96	2900
LHCT-2B	31613	Fecal coliform, col/ml	6/12/96	148
LHCT-2B	31613	Fecal coliform, col/ml	8/28/96	2400
HCRT-1	31613	Fecal coliform, col/ml	6/12/96	45

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Station	Parameter Code	Parameter Name	Date	Value
HCRT-1	31613	Fecal coliform, col/ml	8/28/96	380
NFHT-1	31613	Fecal coliform, col/ml	8/28/96	22
HCRT-2	31613	Fecal coliform, col/ml	6/12/96	43
HCRT-2	31613	Fecal coliform, col/ml	8/28/96	266
HCRT-3	31613	Fecal coliform, col/ml	6/12/96	88
HCRT-3	31613	Fecal coliform, col/ml	8/28/96	320
HCRT-4	31613	Fecal coliform, col/ml	6/12/96	132
HCRT-4	31613	Fecal coliform, col/ml	8/28/96	530
H-1	31613	Fecal coliform, col/ml	6/12/96	960
H-1	31613	Fecal coliform, col/ml	8/28/96	1120
LHCT-2A	535	TSS (mg/l)	6/11/96	36
LHCT-2A	535	TSS (mg/l)	6/12/96	17
LHCT-2A	535	TSS (mg/l)	8/27/96	12
LHCT-2A	535	TSS (mg/l)	8/28/96	512
LHCT-2B	535	TSS (mg/l)	6/11/96	45
LHCT-2B	535	TSS (mg/l)	6/12/96	16
LHCT-2B	535	TSS (mg/l)	8/27/96	9
LHCT-2B	535	TSS (mg/l)	8/28/96	576
HCRT-1	535	TSS (mg/l)	6/11/96	10
HCRT-1	535	TSS (mg/l)	6/12/96	6
HCRT-1	535	TSS (mg/l)	8/27/96	10
HCRT-1	535	TSS (mg/l)	8/28/96	14
NFHT-1	535	TSS (mg/l)	8/27/96	3
NFHT-1	535	TSS (mg/l)	8/28/96	6
HCRT-2	535	TSS (mg/l)	6/11/96	11
HCRT-2	535	TSS (mg/l)	6/12/96	16
HCRT-2	535	TSS (mg/l)	8/27/96	11
HCRT-2	535	TSS (mg/l)	8/28/96	7
HCRT-3	535	TSS (mg/l)	6/11/96	42
HCRT-3	535	TSS (mg/l)	6/12/96	12
HCRT-3	535	TSS (mg/l)	8/27/96	7
HCRT-3	535	TSS (mg/l)	8/28/96	26
HCRT-4	535	TSS (mg/l)	6/11/96	2
HCRT-4	535	TSS (mg/l)	6/12/96	2
HCRT-4	535	TSS (mg/l)	8/27/96	14
HCRT-4	535	TSS (mg/l)	8/28/96	23
H-1	535	TSS (mg/l)	6/11/96	4
H-1	535	TSS (mg/l)	6/12/96	3
H-1	535	TSS (mg/l)	8/27/96	21
H-1	535	TSS (mg/l)	8/28/96	24
LHCT-2A	1105	Al (ug/l)	6/11/96	496.0
LHCT-2A	1105	Al (ug/l)	6/12/96	268.0
LHCT-2A	1105	Al (ug/l)	8/27/96	1300.0
LHCT-2A	1105	Al (ug/l)	8/28/96	18920.0
LHCT-2B	1105	Al (ug/l)	6/11/96	592.0
LHCT-2B	1105	Al (ug/l)	6/12/96	404.0
LHCT-2B	1105	Al (ug/l)	8/27/96	1590.0
LHCT-2B	1105	Al (ug/l)	8/28/96	39595.0
HCRT-1	1105	Al (ug/l)	6/11/96	200.0
HCRT-1	1105	Al (ug/l)	6/12/96	200.0
HCRT-1	1105	Al (ug/l)	8/27/96	1250.0
HCRT-1	1105	Al (ug/l)	8/28/96	1360.0
NFHT-1	1105	Al (ug/l)	8/27/96	1350.0

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Station	Parameter Code	Parameter Name	Date	Value
NFHT-1	1105	Al (ug/l)	8/28/96	1350.0
HCRT-2	1105	Al (ug/l)	6/11/96	439.0
HCRT-2	1105	Al (ug/l)	6/12/96	817.0
HCRT-2	1105	Al (ug/l)	8/27/96	1240.0
HCRT-2	1105	Al (ug/l)	8/28/96	2500.0
HCRT-3	1105	Al (ug/l)	6/11/96	544.0
HCRT-3	1105	Al (ug/l)	6/12/96	328.0
HCRT-3	1105	Al (ug/l)	8/27/96	1250.0
HCRT-3	1105	Al (ug/l)	8/28/96	1950.0
HCRT-4	1105	Al (ug/l)	6/11/96	200.0
HCRT-4	1105	Al (ug/l)	6/12/96	200.0
HCRT-4	1105	Al (ug/l)	8/27/96	880.0
HCRT-4	1105	Al (ug/l)	8/28/96	1590.0
H-1	1105	Al (ug/l)	6/11/96	200.0
H-1	1105	Al (ug/l)	6/12/96	200.0
H-1	1105	Al (ug/l)	8/27/96	1280.0
H-1	1105	Al (ug/l)	8/28/96	1400.0
LHCT-2A	1042	Cu (ug/l)	6/11/96	20.0
LHCT-2A	1042	Cu (ug/l)	6/12/96	20.0
LHCT-2A	1042	Cu (ug/l)	8/27/96	2.5
LHCT-2A	1042	Cu (ug/l)	8/28/96	11.9
LHCT-2B	1042	Cu (ug/l)	6/11/96	20.0
LHCT-2B	1042	Cu (ug/l)	6/12/96	20.0
LHCT-2B	1042	Cu (ug/l)	8/27/96	6.0
LHCT-2B	1042	Cu (ug/l)	8/28/96	16.6
HCRT-1	1042	Cu (ug/l)	6/11/96	20.0
HCRT-1	1042	Cu (ug/l)	6/12/96	20.0
HCRT-1	1042	Cu (ug/l)	8/27/96	10.5
HCRT-1	1042	Cu (ug/l)	8/28/96	2.2
NFHT-1	1042	Cu (ug/l)	8/27/96	5.2
NFHT-1	1042	Cu (ug/l)	8/28/96	2.7
HCRT-2	1042	Cu (ug/l)	6/11/96	20.0
HCRT-2	1042	Cu (ug/l)	6/12/96	20.0
HCRT-2	1042	Cu (ug/l)	8/27/96	4.5
HCRT-2	1042	Cu (ug/l)	8/28/96	5.2
HCRT-3	1042	Cu (ug/l)	6/11/96	20.0
HCRT-3	1042	Cu (ug/l)	6/12/96	20.0
HCRT-3	1042	Cu (ug/l)	8/27/96	3.5
HCRT-3	1042	Cu (ug/l)	8/28/96	3.0
HCRT-4	1042	Cu (ug/l)	6/11/96	20.0
HCRT-4	1042	Cu (ug/l)	6/12/96	20.0
HCRT-4	1042	Cu (ug/l)	8/27/96	4.7
HCRT-4	1042	Cu (ug/l)	8/28/96	10.8
H-1	1042	Cu (ug/l)	6/11/96	20.0
H-1	1042	Cu (ug/l)	6/12/96	20.0
H-1	1042	Cu (ug/l)	8/27/96	8.8
H-1	1042	Cu (ug/l)	8/28/96	6.4
LHCT-2A	1034	T-Cr (ug/l)	6/11/96	15.0
LHCT-2A	1034	T-Cr (ug/l)	6/12/96	15.0
LHCT-2A	1034	T-Cr (ug/l)	8/27/96	5.0
LHCT-2A	1034	T-Cr (ug/l)	8/28/96	18.2
LHCT-2B	1034	T-Cr (ug/l)	6/11/96	15.0
LHCT-2B	1034	T-Cr (ug/l)	6/12/96	15.0

Station	Parameter Code	Parameter Name	Date	Value
LHCT-2B	1034	T-Cr (ug/l)	8/27/96	6.5
LHCT-2B	1034	T-Cr (ug/l)	8/28/96	31.9
HCRT-1	1034	T-Cr (ug/l)	6/11/96	15.0
HCRT-1	1034	T-Cr (ug/l)	6/12/96	15.0
HCRT-1	1034	T-Cr (ug/l)	8/27/96	2.0
HCRT-1	1034	T-Cr (ug/l)	8/28/96	2.0
NFHT-1	1034	T-Cr (ug/l)	8/27/96	2.0
NFHT-1	1034	T-Cr (ug/l)	8/28/96	2.3
HCRT-2	1034	T-Cr (ug/l)	6/11/96	15.0
HCRT-2	1034	T-Cr (ug/l)	6/12/96	15.0
HCRT-2	1034	T-Cr (ug/l)	8/27/96	2.0
HCRT-2	1034	T-Cr (ug/l)	8/28/96	2.0
HCRT-3	1034	T-Cr (ug/l)	6/11/96	15.0
HCRT-3	1034	T-Cr (ug/l)	6/12/96	15.0
HCRT-3	1034	T-Cr (ug/l)	8/27/96	2.0
HCRT-3	1034	T-Cr (ug/l)	8/28/96	2.0
HCRT-4	1034	T-Cr (ug/l)	6/11/96	15.0
HCRT-4	1034	T-Cr (ug/l)	6/12/96	15.0
HCRT-4	1034	T-Cr (ug/l)	8/27/96	2.0
HCRT-4	1034	T-Cr (ug/l)	8/28/96	2.0
H-1	1034	T-Cr (ug/l)	6/11/96	15.0
H-1	1034	T-Cr (ug/l)	6/12/96	15.0
H-1	1034	T-Cr (ug/l)	8/27/96	2.0
H-1	1034	T-Cr (ug/l)	8/28/96	2.0
LHCT-2A	1002	As (ug/l)	6/11/96	10.0
LHCT-2A	1002	As (ug/l)	6/12/96	10.0
LHCT-2A	1002	As (ug/l)	8/27/96	5.0
LHCT-2A	1002	As (ug/l)	8/28/96	8.6
LHCT-2B	1002	As (ug/l)	6/11/96	10.0
LHCT-2B	1002	As (ug/l)	6/12/96	10.0
LHCT-2B	1002	As (ug/l)	8/27/96	5.0
LHCT-2B	1002	As (ug/l)	8/28/96	15.3
HCRT-1	1002	As (ug/l)	6/11/96	10.0
HCRT-1	1002	As (ug/l)	6/12/96	10.0
HCRT-1	1002	As (ug/l)	8/27/96	5.0
HCRT-1	1002	As (ug/l)	8/28/96	5.0
NFHT-1	1002	As (ug/l)	8/27/96	5.0
NFHT-1	1002	As (ug/l)	8/28/96	5.0
HCRT-2	1002	As (ug/l)	6/11/96	10.0
HCRT-2	1002	As (ug/l)	6/12/96	10.0
HCRT-2	1002	As (ug/l)	8/27/96	5.0
HCRT-2	1002	As (ug/l)	8/28/96	5.0
HCRT-3	1002	As (ug/l)	6/11/96	10.0
HCRT-3	1002	As (ug/l)	6/12/96	10.0
HCRT-3	1002	As (ug/l)	8/27/96	5.0
HCRT-3	1002	As (ug/l)	8/28/96	5.0
HCRT-4	1002	As (ug/l)	6/11/96	10.0
HCRT-4	1002	As (ug/l)	6/12/96	10.0
HCRT-4	1002	As (ug/l)	8/27/96	5.0
HCRT-4	1002	As (ug/l)	8/28/96	5.0
H-1	1002	As (ug/l)	6/11/96	10.0
H-1	1002	As (ug/l)	6/12/96	10.0
H-1	1002	As (ug/l)	8/27/96	5.0

Model Application for TMDL Development in the Hurricane Creek Watershed

Station	Parameter Code	Parameter Name	Date	Value
H-1	1002	As (ug/l)	8/28/96	5.0
LHCT-2A	74010	Fe (mg/L)	6/11/96	0.963
LHCT-2A	74010	Fe (mg/L)	6/12/96	0.938
LHCT-2A	74010	Fe (mg/L)	8/27/96	0.69
LHCT-2A	74010	Fe (mg/L)	8/28/96	0.65
LHCT-2B	74010	Fe (mg/L)	6/11/96	1.22
LHCT-2B	74010	Fe (mg/L)	6/12/96	1.25
LHCT-2B	74010	Fe (mg/L)	8/27/96	1.47
LHCT-2B	74010	Fe (mg/L)	8/28/96	21.56
HCRT-1	74010	Fe (mg/L)	6/11/96	0.832
HCRT-1	74010	Fe (mg/L)	6/12/96	0.877
HCRT-1	74010	Fe (mg/L)	8/27/96	1.65
HCRT-1	74010	Fe (mg/L)	8/28/96	16.99
NFHT-1	74010	Fe (mg/L)	8/27/96	0.59
NFHT-1	74010	Fe (mg/L)	8/28/96	2.11
HCRT-2	74010	Fe (mg/L)	6/11/96	0.528
HCRT-2	74010	Fe (mg/L)	6/12/96	0.724
HCRT-2	74010	Fe (mg/L)	8/27/96	0.48
HCRT-2	74010	Fe (mg/L)	8/28/96	0.39
HCRT-3	74010	Fe (mg/L)	6/11/96	0.655
HCRT-3	74010	Fe (mg/L)	6/12/96	0.601
HCRT-3	74010	Fe (mg/L)	8/27/96	0.67
HCRT-3	74010	Fe (mg/L)	8/28/96	0.64
HCRT-4	74010	Fe (mg/L)	6/11/96	0.351
HCRT-4	74010	Fe (mg/L)	6/12/96	0.428
HCRT-4	74010	Fe (mg/L)	8/27/96	0.99
HCRT-4	74010	Fe (mg/L)	8/28/96	2.31
H-1	74010	Fe (mg/L)	6/11/96	0.292
H-1	74010	Fe (mg/L)	6/12/96	0.372
H-1	74010	Fe (mg/L)	8/27/96	1.15
H-1	74010	Fe (mg/L)	8/28/96	1.57

Hurricane Creek Modeling Report Appendix B

Mining Permits

Permit Number	Type of Mine	Permit Name	Permitted Area	Permit Issued	Permit Expired
P1747	Surface	CRAWFORD COAL COMPANY INC	44	9/19/78	7/24/79
P1830	Surface	CRAWFORD COAL COMPANY INC	13	1/5/79	1/4/80
P1906	Surface	PETERSON COAL COMPANY	60	2/1/79	1/31/80
P2044	Surface	CRAWFORD COAL COMPANY INC	70	7/24/79	7/23/80
P2067	Surface	ROLAND PUGH MINING INC	20	7/3/79	7/2/80
P2069	Surface	ABSTON CONSTRUCTION COMPANY INC	35	9/7/79	9/6/80
P2070	Surface	ABSTON CONSTRUCTION COMPANY INC	74	9/7/79	9/6/80
P2100	Surface	H & H MINING COMPANY INC	5	8/2/79	8/1/80
P2112	Surface	H & H MINING COMPANY INC	21	8/22/79	8/21/80
P2138	Surface	STANLEY EXCAVATING CO INC	26	9/7/79	9/6/80
P2240	Surface	CRAWFORD COAL COMPANY INC	20	12/12/79	12/11/80
P2268	Surface	ABSTON CONSTRUCTION COMPANY INC	26	1/11/80	1/10/81
P2285	Surface	CRAWFORD COAL COMPANY INC	60	2/11/80	2/10/81
P2440	Surface	ABSTON CONSTRUCTION COMPANY INC	101	9/7/80	9/6/81
P2665	Surface	ABSTON CONSTRUCTION COMPANY INC	86	6/8/81	6/7/82
P2688	Surface	MITCHELL AND NEELY INC	333	6/9/81	7/24/82
P2704	Surface	DRUMMOND COAL COMPANY	240	6/29/81	7/31/82
P2806	Surface	ABSTON CONSTRUCTION COMPANY INC	54	9/9/81	9/8/82
P2887	Surface	ABSTON CONSTRUCTION COMPANY INC	125	12/1/81	11/30/82
P2907	Surface	STANLEY EXCAVATING CO INC	51	12/4/81	12/3/82
P2936	Surface	CRAWFORD COAL COMPANY INC	125	12/16/81	12/15/82
P2970	Surface	ABSTON CONSTRUCTION COMPANY INC	210	3/23/82	3/22/83
P2979	Surface	BASIN COAL COMPANY INC	85	1/22/82	1/21/83
P2998	Surface	MITCHELL AND NEELY INC	212	2/16/82	2/15/82
P3072	Surface	WEST ALABAMA FOSSIL FUEL INC	104	3/18/82	3/17/83

Permit Number	Type of Mine	Permit Name	Permitted Area	Permit Issued	Permit Expired
P3153	Surface	ABSTON CONSTRUCTION COMPANY INC	73	5/19/82	5/18/83
P3155	Surface	STANLEY EXCAVATING CO INC	63	5/19/82	5/18/83
P3160	Surface	MITCHELL AND NEELY INC	34	5/12/82	5/11/83
P3190	Surface	DRUMMOND COAL COMPANY	80	7/5/83	7/3/89
P3256	Underground	JIM WALTER RESOURCES INC	1262	3/3/83	3/1/03
P3288	Surface	BASIN COAL COMPANY INC	66	5/17/83	5/16/85
P3307	Surface	ABSTON CONSTRUCTION COMPANY INC	57	4/8/83	4/7/84
P3308	Surface	ABSTON CONSTRUCTION COMPANY INC	106	4/25/84	4/24/87
P3310	Surface	ABSTON CONSTRUCTION COMPANY INC	157	7/29/83	7/28/98
P3335	Surface	MITCHELL AND NEELY INC	399	9/9/83	9/8/93
P3493	Surface	ABSTON CONSTRUCTION COMPANY INC	152	4/7/86	4/6/91
P3519	Surface	ABSTON CONSTRUCTION COMPANY INC	127	2/6/89	2/5/94
P3526	Surface	ABSTON CONSTRUCTION COMPANY INC	31	11/3/86	11/2/89
P3541	Surface	ROCKY RIDGE COAL INC	243	6/30/87	6/29/92
P3547	Surface	DOVE COAL CORPORATION	521	9/13/88	9/12/93
P3548	Surface	ABSTON CONSTRUCTION COMPANY INC	101	8/28/89	8/27/94
P3576	Surface	ABSTON CONSTRUCTION COMPANY INC	134	10/26/88	10/25/93
P3613	Surface	DOVE COAL CORPORATION	97	1/3/90	1/2/95
P3631	Surface	APEX COAL CORPORATION	197	10/25/90	10/24/95
P3648	Surface	DRUMMOND COMPANY INC	605	1/23/91	1/22/96
P3725	Surface	SOUTHLAND RESOURCES INC	0	10/1/93	9/30/94
P3728	Surface	DRUMMOND COMPANY INC	582	3/8/94	3/7/99
P3810	Surface	BLACK WARRIOR MINERALS INC	448	3/30/00	3/29/05
T0033	T	ROCKY RIDGE COAL INC	2	2/24/87	5/23/87
X0016	X	ABSTON CONSTRUCTION COMPANY INC	26	4/29/86	6/29/86

Hurricane Creek Modeling Report Appendix C

Land Use Distribution

Subwatershed	Barren	Cropland	Forest	Pasture	Strip Mining	Urban Pervious	Wetlands	Urban Impervious	Unpaved Road	Paved Road	Undergr
1	5.34	12.23	437.65	2.22	43.37	0.55	0	1	1.3	2	0
2	1.11	33.14	571.64	40.7	289.12	5.36	0	3.31	2.5	14.7	0
3	1.33	3.34	225.2	8.01	0	0	0	0	0.6	2.5	0
4	6	12.68	439.27	10.9	2.67	29.76	0	7.83	1.4	10.8	0
5	0.22	70.5	673.24	67.16	22.91	0.2	0	1.13	2.2	22.4	0
6	0	0	158.82	0	0	1.95	0	0.27	0.4	0.4	0
7	9.12	41.14	710.15	183.7	0	217.69	0	88.11	3.4	58	0
8	3.11	2.67	437.65	14.23	0	11.2	0	4.81	1.4	10.5	46
9	6.67	5.56	110.12	7.11	0	0.82	0	0.29	0.3	1.9	0
10	4.45	62.94	805.03	171.25	0	221.94	0	131.9	3.8	68.6	0
11	0.22	13.34	563.12	52.71	0	32.61	0	24.1	1.9	20.4	0
12	16.9	138.78	850.93	86.07	45.15	83.94	0	63.73	3.5	44.2	0
13	15.12	7.78	1462.3	104.53	0	164.08	0	73.89	4.9	35.8	0
14	5.34	68.28	1066.19	64.27	25.13	12.47	88.74	19.78	3.6	26.2	0
15	34.03	156.12	1336.8	154.79	0	5.06	4.89	8.07	4.5	15.7	0
16	1.78	99.63	2242.73	177.03	0	6.25	12.46	7.31	6.7	20	0
17	0.22	19.79	411.14	44.7	0	4.31	0	1.69	1.3	5.5	0
18	130.77	57.82	2139.49	90.74	0	8.44	0	14.02	6.6	58.7	0
19	10.68	125.88	2270.28	172.36	0	18.22	0	17.6	7.1	58.3	0
20	149.23	42.7	903.06	30.25	758.6	11.68	0	3	5	19.4	0
21	11.12	58.94	775.86	21.35	1168.93	0.93	0	4.18	5.6	25.2	0
22	6.23	3.34	846.9	0.67	501.51	0.69	0	1.75	3.6	4.3	0
23	10.45	2	210.96	0.67	325.37	0	0	0	1.5	5	0
24	7.78	0	32.92	0	12.9	0.03	0	0.19	0.1	0.6	0
25	4.67	50.04	1550.65	46.7	654.52	5.51	0	6.28	6.2	31.6	0
26	43.37	0.22	268.11	3.78	329.15	0.1	0	0.57	1.7	1.5	0
27	0	0.67	13.17	7.34	16.46	0	0	0	0.1	0.6	0
28	11.12	4.67	136.65	18.68	370.07	0.26	0	0.4	1.4	3.3	0
29	0	35.36	468.84	221.95	197.27	8.87	0	5.59	2.6	18.4	0
30	117.43	153.01	1557.19	271.32	235.3	3.19	0	3.7	6.3	36.8	0
31	2.67	159.46	897.99	329.82	0.44	5.48	0	6.52	3.8	35	0
32	0	3.78	133.93	46.93	42.92	0	0	0	0.6	4.1	0

Hurricane Creek Watershed July 2001

Subwatershed	Barren	Cropland	Forest	Pasture	Strip Mining	Urban Pervious	Wetlands	Urban Impervious	Unpaved Road	Paved Road	Undergr
33	0	2.45	365.82	1.11	0	0.37	0	2.08	1	3.4	0
34	0	6.45	569.47	5.56	2.67	0.07	0	0.37	1.5	5.4	0
35	208.17	9.12	620.95	10.01	0	0.1	0	0.57	2.2	8.4	0
36	27.8	1.11	249.14	1.11	0	0.07	0	0.37	0.7	0.9	0
37	0.44	6.23	313.38	43.14	806.42	0.55	0	1	3.1	7.4	0
38	8.67	1.78	207.62	4.67	93.19	0.13	0	0.76	0.8	4.3	0
39	47.59	22.68	1066.58	22.24	17.57	1.02	0	3.65	3.1	9.5	0
40	0	1.11	113.01	0.22	0	0.07	0	0.37	0.3	0.7	0
41	5.56	76.28	1475.67	43.37	38.12	6.23	0	9.34	4.5	35.6	17
42	0	42.26	1194	44.04	0	2.06	0	8.4	3.5	19.6	0
43	0	31.8	344.08	17.79	0	0.17	0	0.94	1.1	7.5	0
44	0	49.37	577.93	89.85	0	1.12	0	3.11	1.9	14.2	0
45	0	34.47	389.32	41.81	0	1.93	0	2.3	1.3	8.6	0
46	0	1.56	42.18	0	0	0	0	0	0.1	0.2	0
47	0	54.71	822.2	51.15	0	0.17	0	0.94	2.5	12.9	0
48	1.11	32.47	1734.16	42.48	0	8.79	0	4.33	4.9	33.1	0
49	1.11	300.91	1274.69	379.19	0	0.27	0	1.51	5.2	22.2	0
50	2.22	1.78	242.02	2	20.24	0.33	0	0.78	0.7	1.2	0
51	0	9.12	265.75	5.78	100.3	0.03	0	0.19	1	4.9	0
52	0	1.11	83.75	1.33	0	0	0	0	0.2	0	0
53	0.89	1.56	530.43	1.11	20.68	0	0	0	1.5	6.6	0
54	0	1.33	169.79	15.57	17.79	0	0	0	0.5	3.6	0
55	22.24	25.8	812.31	29.8	537.54	8.86	0	3.6	3.8	7.4	0
56	0.44	3.11	701.63	0.67	5.78	0.07	0	0.37	1.9	0.9	0
57	0.22	2	328.68	0.22	31.36	0.03	0	0.19	1	0	0
58	0	0.89	213.39	14.45	763.05	9.97	0	5.82	3.1	13.5	0
59	0	0	87.13	0.67	5.56	0	0	0	0.2	0	0
60	0	2	1023.24	12.01	733.25	0.23	0	1.33	5.4	19.5	0
61	0	0	80.73	0.44	0	0	0	0	0.2	0	0
62	0.22	0	384.78	0.22	0	0	0	0	1	2.3	0
63	0.44	0.22	80.29	0	0	0	0	0	0.2	0	0
64	0	0.67	474.67	0.44	0.89	0	0	0	1.3	2.2	0
65	0	6.23	504.04	0.67	0	0.1	0	0.57	1.8	3.4	0

Model Application for TMDL Development in the Hurricane Creek Watershed

Subwatershed	Barren	Cropland	Forest	Pasture	Strip Mining	Urban Pervious	Wetlands	Urban Impervious	Unpaved Road	Paved Road	Undergr
66	23.35	9.12	806.5	26.91	146.34	3.2	0	0.8	2.7	7.8	0
67	0.44	6.45	958.57	4	0	1.86	0	0.81	2.6	3.6	0
68	0	1.11	571.45	0.67	0.22	0	0	0	1.5	1.8	0
69	0	15.79	2041.73	34.92	0	0.57	0	3.21	5.5	13	0
70	2	0.67	394.52	1.56	0	0	0	0	1.1	3.1	0
71	0.67	14.01	2470.52	10.01	28.02	0.2	0	1.13	6.6	8.5	0
72	0	24.46	1726.47	60.27	0	0.07	0	0.37	4.8	15.6	0
TOTAL	970.06	2248.00	51020.57	3473.40	8410.78	910.23	106.09	560.23	182.20	975.20	63.00

Hurricane Creek Modeling Report Appendix D

Hydrology Calibration

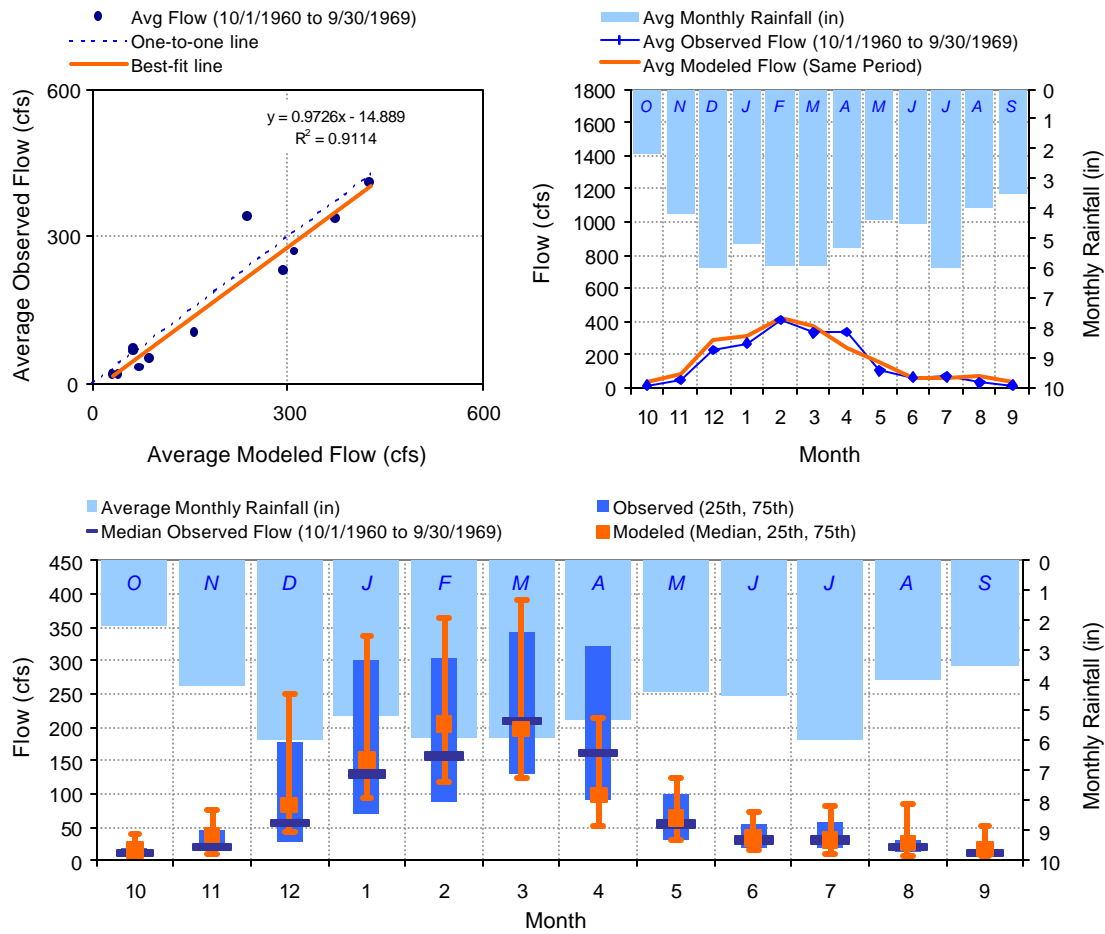


Figure D-1. Hydrology Calibration for 1960-1969 at USGS Flow gage 02463500

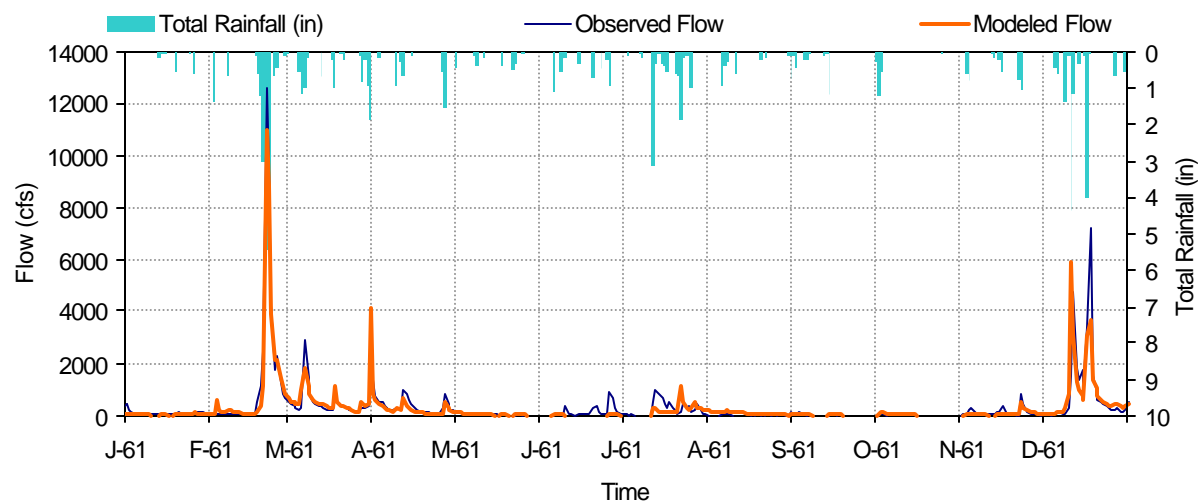


Figure D-2. Hydrology calibration (no mines) at USGS gage 02463500; 1961

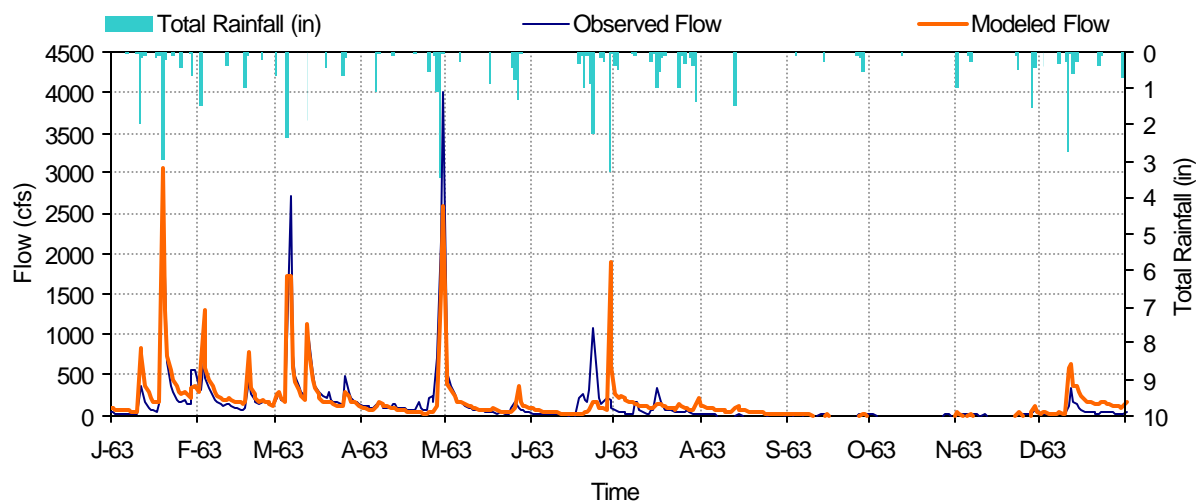


Figure D-3. Hydrology calibration (no mines) at USGS gage 02463500; 1963

Figure D-4. Hydrology calibration (with mines) at USGS 02463510; water year 1981

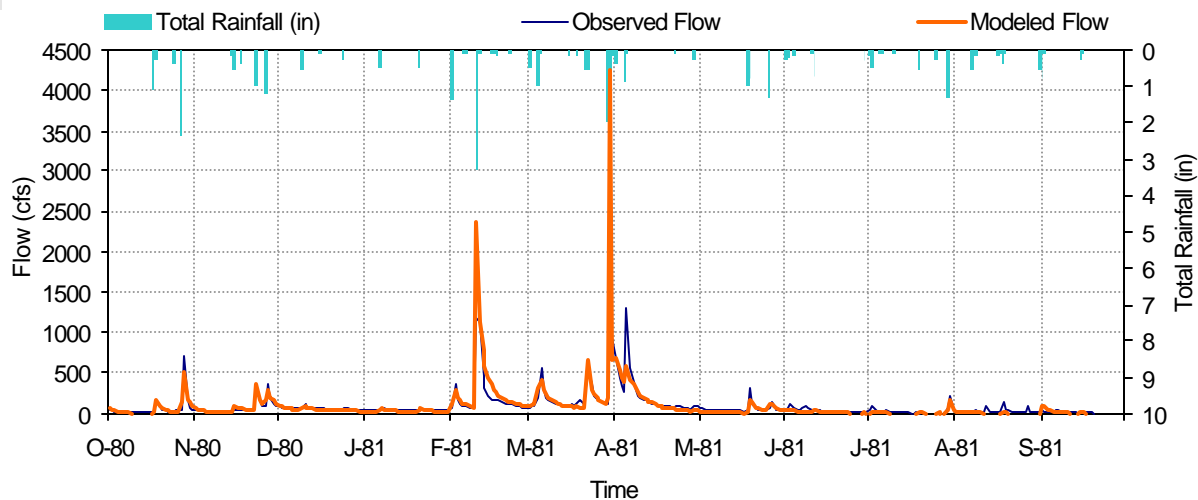
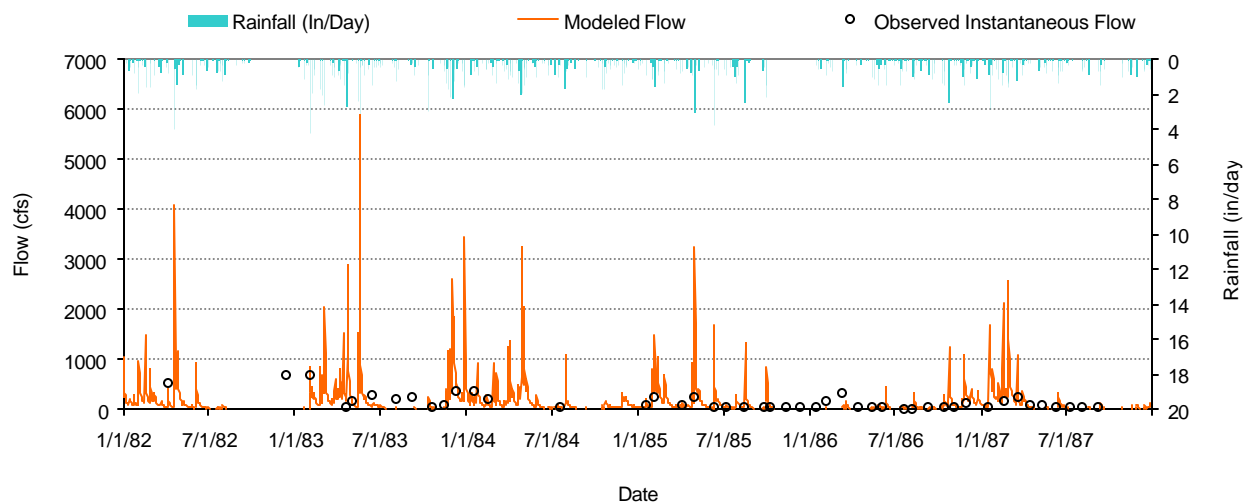


Figure D-5. Hydrology Validation (1982-1987) at water quality station H-1



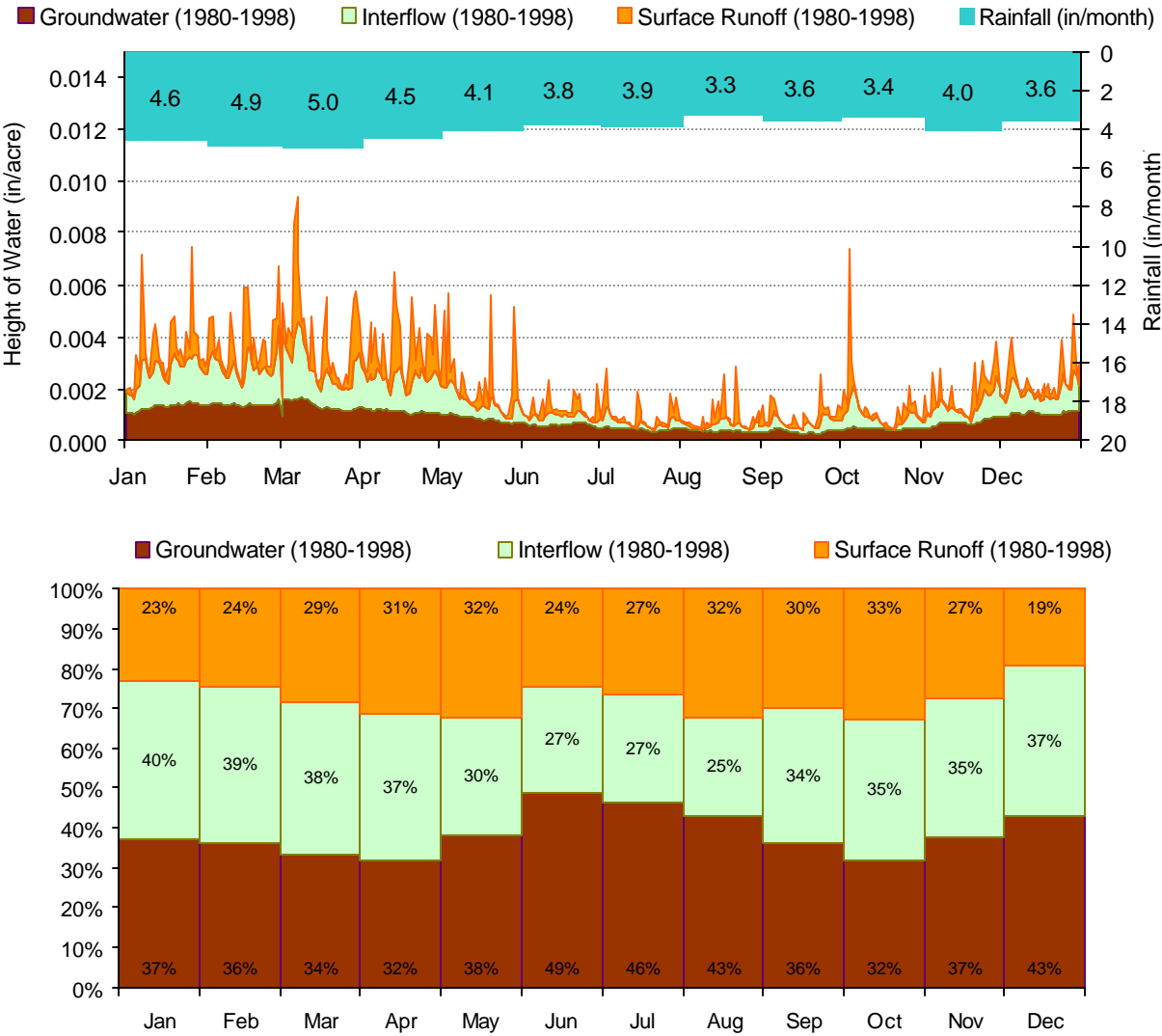


Figure D-6. Modeled hydrograph separation (Average distribution 1980-1998)

Hurricane Creek Modeling Report Appendix E

Water Quality Calibration

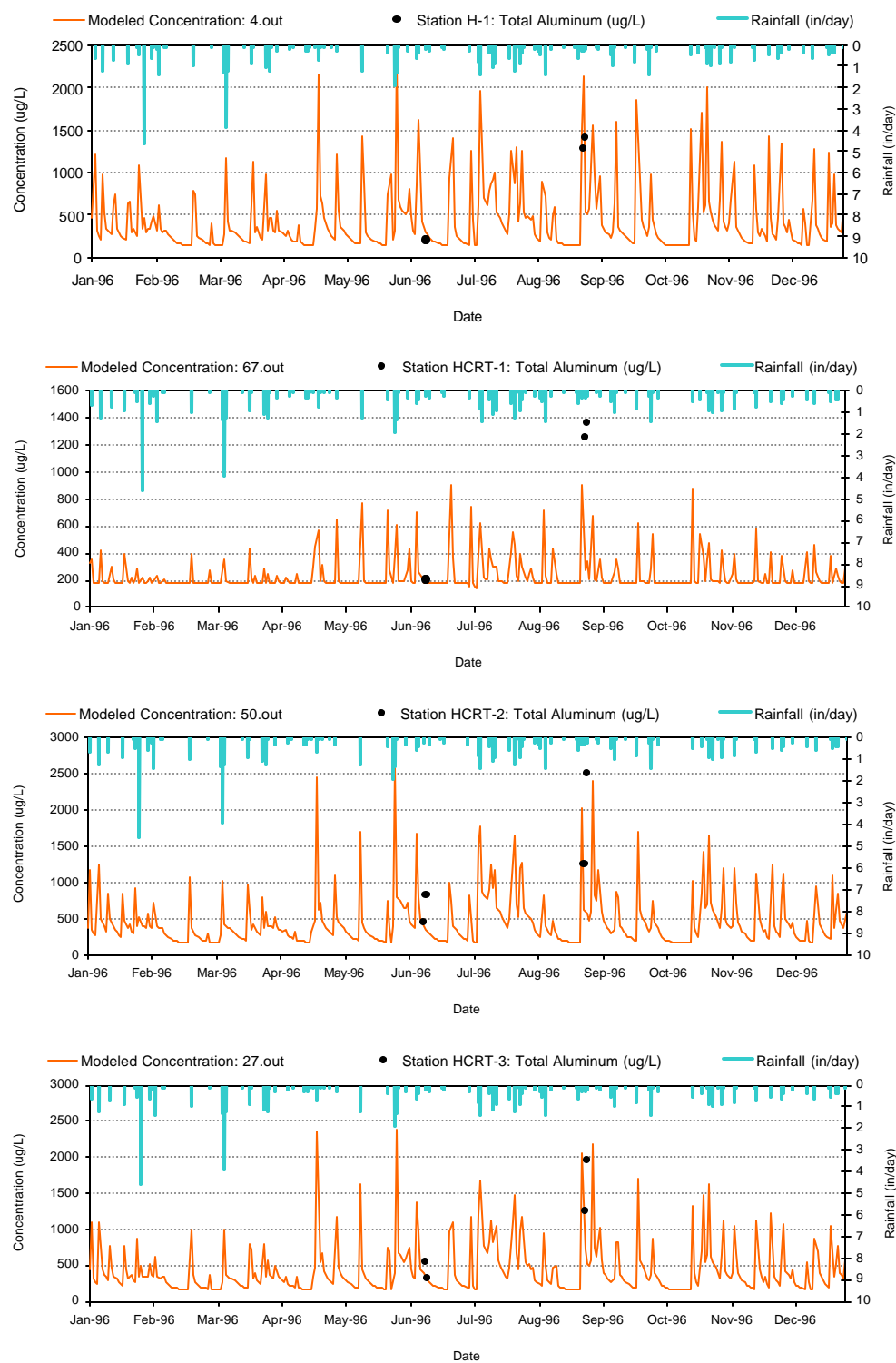


Figure E-1. Aluminum calibration at water quality stations H-1, HCRT-1, HCRT-2, and HCRT-3



Figure E-2. Aluminum calibration at water quality stations HCRT-4, LHCT-2A, LHCT-2B, and NFHT-1

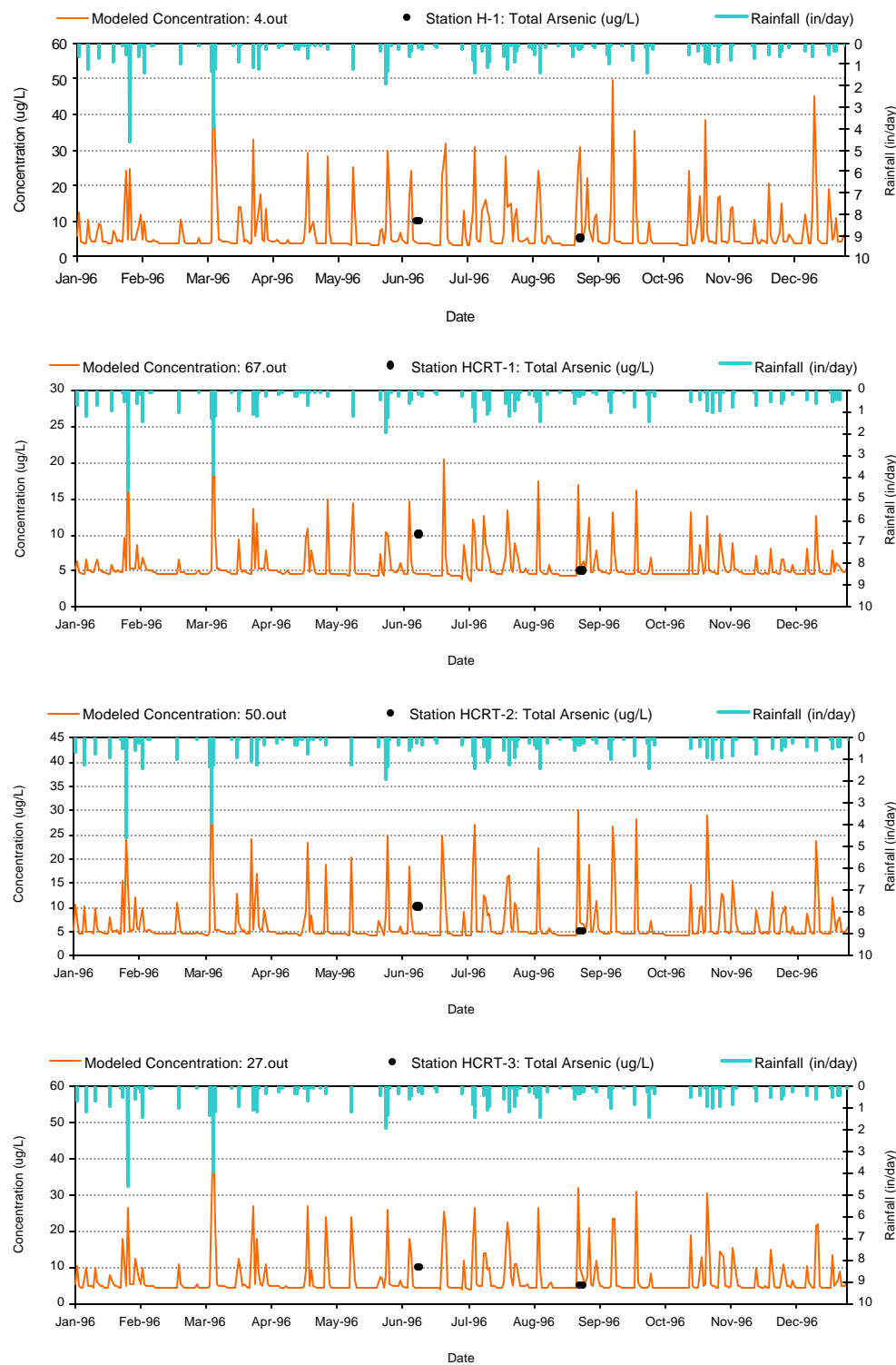


Figure E-3. Arsenic calibration at water quality stations H-1, HCRT-1, HCRT-2, and HCRT-3

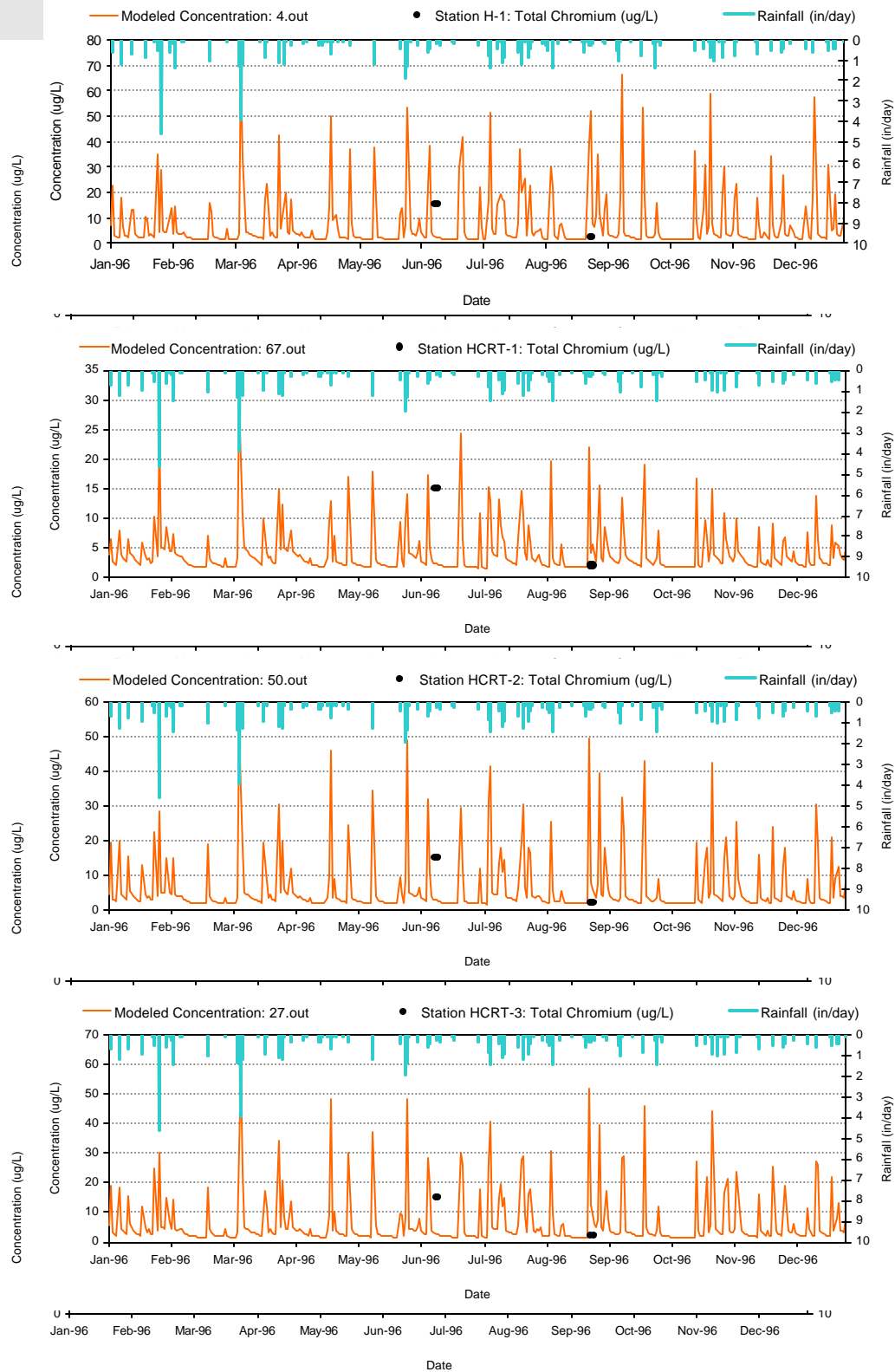


Figure E-4. Arsenic calibration at water quality stations HCRT-4, LHCT-2A, LHCT-2B, and NFHT-1

Figure E-5. Chromium calibration at water quality stations H-1, HCRT-1, HCRT-2, and HCRT-3

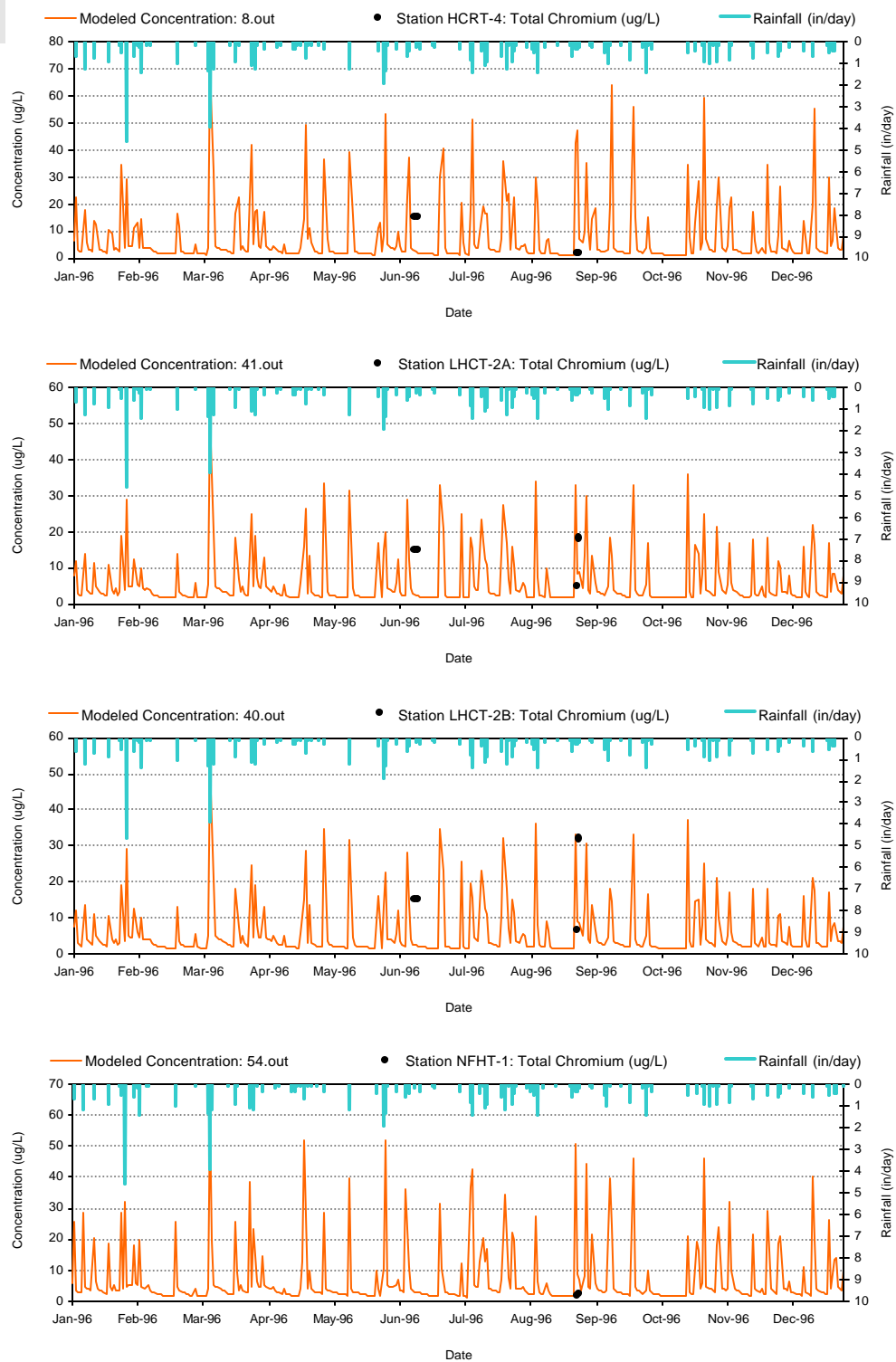


Figure E-6. Chromium calibration at water quality stations HCRT-4, LHCT-2A, LHCT-2B, and NFHT-1

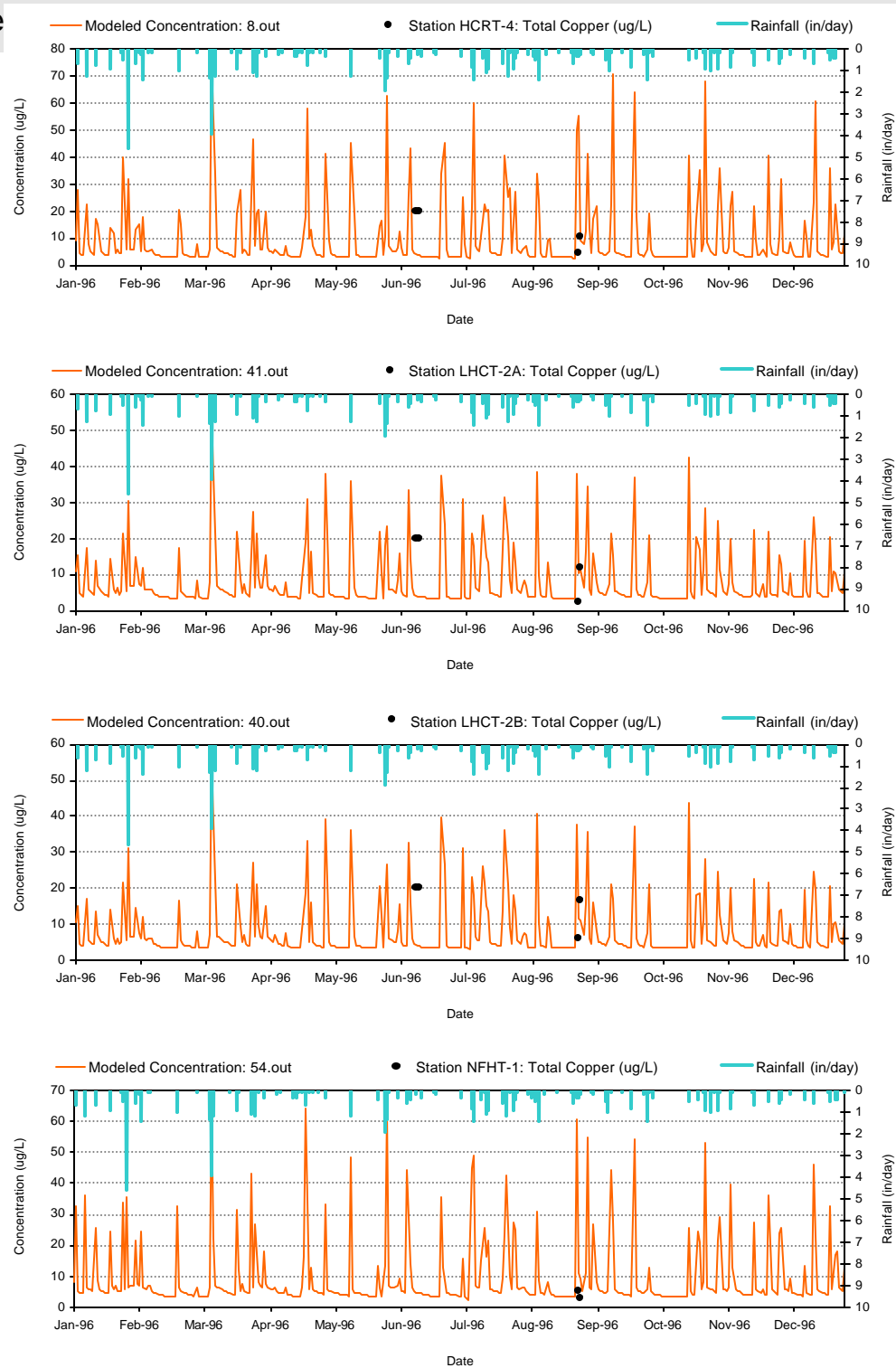


Figure E-7. Copper calibration at water quality station H-1, HCRT-1, HCRT-2, and HCRT-3

Figure E-8. Copper calibration at water quality stations HCRT-4, LHCT-2A, LHCT-2B, and NFHT-1

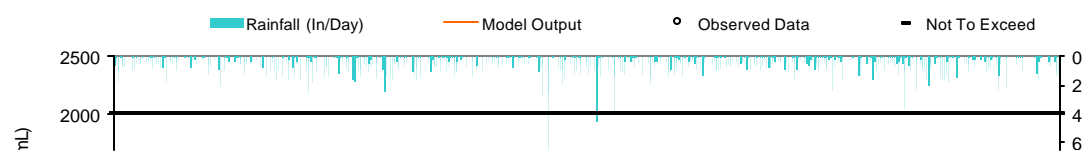


Figure E-9. Fecal coliform calibration at water quality station H-1 (1993-1998)

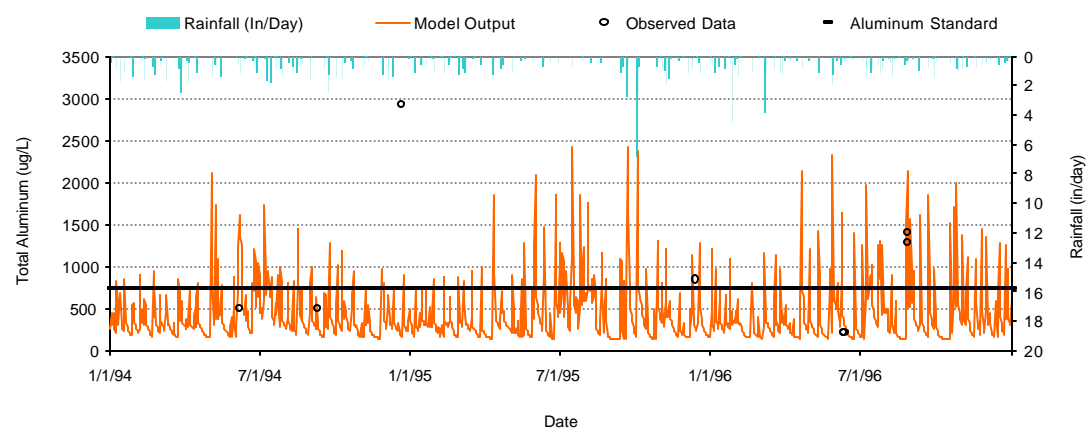


Figure E-10. Aluminum calibration at water quality station H-1 (1994-1996)

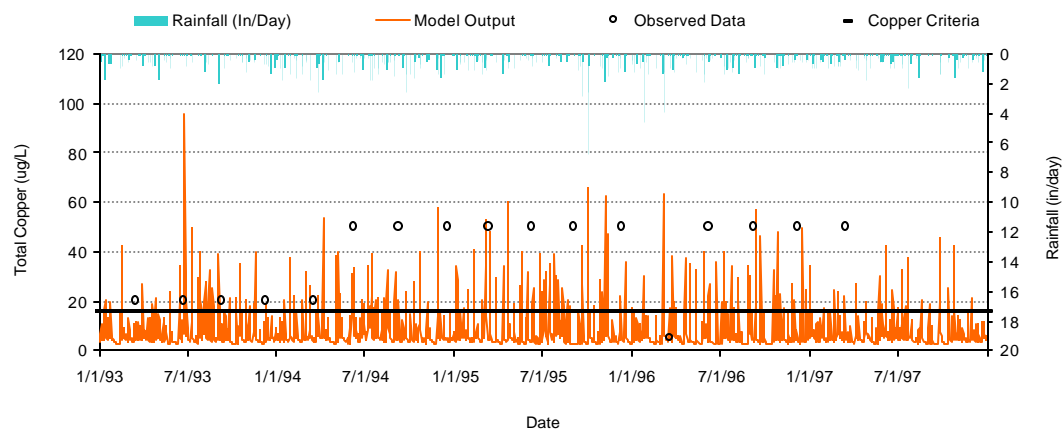


Figure E-11. Copper calibration at water quality station H-1 (1993-1997)

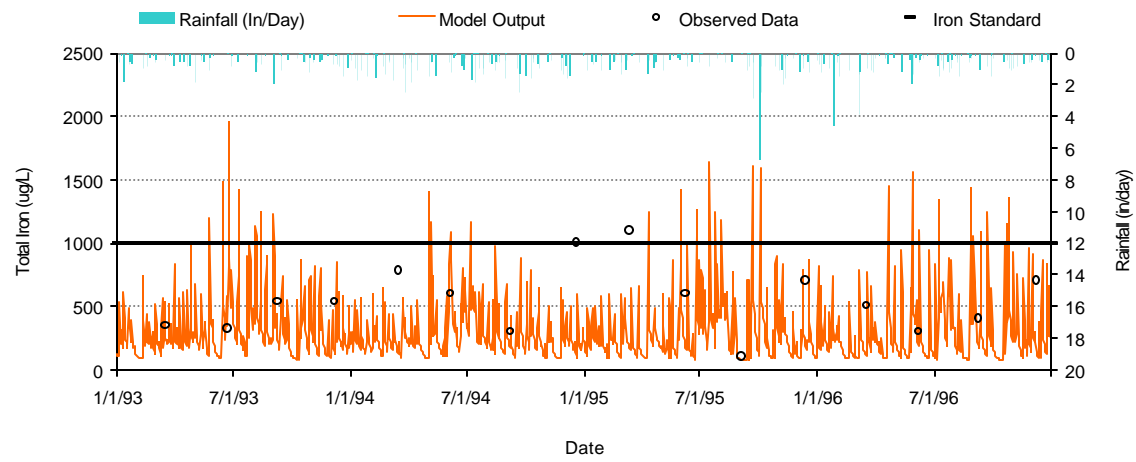


Figure E-12. Iron calibration at water quality station H-1 (1993-1996)

Appendix B:

Hurricane Creek Watershed
Stream Bioassessment Report

Tuscaloosa, Alabama



Prepared by

Lonnie Dorn, Hoke Howard, Morris Flexner
U.S. Environmental Protection Agency
Region 4
Athens and Atlanta, Georgia

November 2000

INTRODUCTION

As outlined in the Clean Water Act of 1972, those waters considered to be impaired and threatened must be improved to meet their designated uses. Impairment is generally based on meeting or not meeting numerical criteria associated with a water body's classification. Standards are typically based on measures of water column chemistry using data from field methods or laboratory analytical techniques. Problems arise when chemical standards are the only criteria used to evaluate a particular water body because single water chemistry measurements may not represent general contaminant conditions. Ascription of chemical effects as the cause of aquatic faunal decline can be misleading if there are multiple sources of nonpoint pollution entering a water body and the physical habitat is degraded.

The essential goal of the Clean Water Act of 1972 is to maintain and restore biological integrity to waters of the U.S. Biological integrity is defined as the ability of an ecosystem *"to support and maintain a balanced, integrated, adaptive community of organisms having a composition, diversity, and functional organization comparable with that of natural habitats of the region"* (Karr and Dudley 1981). Listing impaired waters (303 (d) listing) as required by the Clean Water Act and application of the Total Maximum Daily Load (TMDL) concept (which establishes limits for contaminants so that the water body can meet its designated use), are two approaches used to protect and restore waterbodies that are influenced by multiple contaminants and other stressors.

BACKGROUND

In the Alabama Department of Environmental Management (ADEM) 1994-95 Water Quality Report to Congress (June 1996), 19 miles of Hurricane Creek in the vicinity of Tuscaloosa, Alabama were identified on the 303 (d) list as being impaired and not fully supporting the water quality classification of Fish & Wildlife (Figure 1). The listing was based on assessments of the fish and macroinvertebrate communities at ambient monitoring stations within the Hurricane Creek watershed. ADEM listed the 19 mile segment as impaired due to metals, low pH, siltation, and organic enrichment, resulting from surface coal mining, subsurface mining, petroleum drilling activities, and run-off from mine tailings (ADEM 1996a).

In 1997 two adjoining civil lawsuits, CV-97-S-0714-M and CV-97-S-2518-M, were filed in the U.S. District Court for the Northern District of Alabama against U.S. EPA. These lawsuits, which compelled U.S. EPA to establish TMDLs for waters listed on the 303 (d) in Alabama pursuant to section 303 (d) of the Clean Water Act, resulted in a Consent Decree and Settlement Agreement signed November 5, 1998 between U.S. EPA & and the plaintiffs (U.S. District Court 1998). Language in the Settlement Agreement for these civil actions required U.S. EPA to evaluate Hurricane Creek focusing on impaired segments set forth in Alabama's 1996 section 303 (d) list. The purpose of this study was 1) to assess the current water quality of Hurricane Creek, 2) to identify potential point and nonpoint

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sources of pollutants currently being introduced into Hurricane Creek, and 3) to obtain data and information necessary to determine the appropriate TMDLs for pollutants which may be causing Hurricane Creek to not meet applicable water quality standards. Within two years following the effective date of the Consent Decree (November 2000), U.S. EPA will issue a report regarding items 1) and 2) above. By July 2001, U.S. EPA will provide plaintiffs with a summary of the data and information developed pursuant to item 3) above. In addition, U.S. EPA will develop a TMDL for Hurricane Creek by July 2001, provided that ADEM has not already done so.

Biologists from the Ecological Assessment Branch (EAB) of the Science and Ecosystem Support Division (SESD) have, in working with the ADEM, the Alabama Surface Mining Commission (ASMC), the Alabama Geological Survey (AGS), and the Alabama Rivers Alliance (ARA), acquired biological community and habitat information as well as land use/land cover data on the Black Warrior River basin, where the Hurricane Creek watershed is located. During the week of April 24-27, 2000, staff from the EAB, the Water Management Division (WMD), and the Environmental Services Assistance Team (ESAT) conducted bioassessments of the benthic macroinvertebrate communities of Hurricane, Little Hurricane, Kepple, and Cottdale Creeks in the vicinity of Tuscaloosa, Alabama. These studies were conducted in support of ADEM and in response to recent litigation brought against U.S. EPA, Region 4 in the U.S. District Court for the Northern District of Alabama for failure to enforce the Clean Water Act. In addition to benthic macroinvertebrate data collected during this period, *in situ* water chemistry data as well as habitat evaluation data were also collected.

HISTORICAL BIOLOGICAL STUDIES

Macroinvertebrate communities at five sites within the Hurricane Creek watershed were assessed in 1996 by ADEM during an intensive survey of water quality condition (1996b). An assessment of aquatic macroinvertebrate fauna was also conducted in the North Fork of Hurricane Creek during the 1997 Nonpoint Source Screening Assessment of the Black Warrior River Basin (ADEM 1999), and fish communities at six sites within the watershed were assessed by the Alabama Geological Survey in 1998. These assessments generally indicated that the North Fork Hurricane Creek was severely impaired based on the community structure of the macroinvertebrate assemblages. The downstream-most station on Hurricane Creek assessed by ADEM was H- 1. This location has been monitored for chemical contaminants in conjunction with ADEM's ambient monitoring program since 1974 and was established in order to detect nonpoint discharges from surface mining (ADEM 1996a). The aquatic macroinvertebrate assessment conducted in 1996 indicated moderate impairment at H-1. Results of chemical analyses from the 1996 study by ADEM indicated that conductivity, fecal coliform bacteria, and total dissolved solids were elevated above the background station (HCRT-1) (ADEM 1996b). ADEM identified Hurricane Creek as a priority subwatershed for further ecological evaluation as a result of these findings. Table 2 provides a comparison of the benthic macroinvertebrate data collected by ADEM in 1996 and 1997 to the macroinvertebrate data collected for this study. Figure 2 identifies the stations sampled by ADEM in 1996.

STUDY OBJECTIVES

The purpose of this study was to assess the overall condition of the aquatic communities in the Hurricane Creek watershed. The condition of the benthic communities was to be evaluated to determine whether Hurricane Creek meets the criteria for the Fish and Wildlife (F&W) stream classification, and to assist in satisfying the November 2000 reporting requirement of the Settlement Agreement as described above (U.S. District Court, 1998). The present study was also intended to characterize the macroinvertebrate communities of the watershed and update the historical macroinvertebrate data collected by ADEM in 1996 and 1997. Comparison of the 1996 data with the 1997 data revealed similar conditions of impairment related to the benthic community and water chemistry within the Hurricane Creek watershed. Information gathered by U.S. EPA during this biological investigation will be used in developing a TMDL for the watershed.

STUDY AREA

Hurricane Creek is a subwatershed comprising approximately 128 square miles within the upper portion of the Black Warrior River Basin. From its headwaters in eastern Tuscaloosa County, Alabama the creek flows westerly through old and new mining activity and residential areas to its confluence with the Black Warrior River immediately north of Tuscaloosa. The watershed lies in the Shale Hills ecoregion, within the outcrop area of the Pottsville Formation. This formation contains coal seams that have been extensively mined resulting in impacts such as acid-mine drainage and sediment deposition in the watershed. Percent land cover was estimated as 3% low intensity, residential/industrial; 3% transitional barren; 37% deciduous forest; 17% evergreen forest; 33% mixed forest; 3% pasture/hay; and 3% row crop (U.S. EPA, 1997). Nine current mining NPDES permits and thirty-six construction/storm water permits have been issued within the Hurricane Creek subwatershed (ADEM 1999).

Thirteen sampling stations for the rapid bioassessment were located in Hurricane Creek, Little Hurricane Creek, North Fork Hurricane Creek, and major tributaries (Kepple and Cottondale Creeks) (Table 2). There was not an established ecological reference site in the Shale Hills ecoregion. However, following a suggestion by ADEM, Wolf Creek was sampled as a possible reference site for this ecoregion.

STUDY METHODS

Benthic Macroinvertebrates- A multi-habitat Rapid Bioassessment Protocol III was utilized for sampling the benthic macroinvertebrates (U.S. EPA, 1999). The RBP III includes collection of macroinvertebrates using the standard D-frame biological dip net from a variety of habitat types, a habitat evaluation, and *in situ* measurements of pH, conductivity, temperature, and dissolved oxygen.

The RBP III is U.S. EPA's most intensive and detailed level of sampling and data evaluation for benthic macroinvertebrate studies. The collected benthic macroinvertebrates are identified to the genus level by scientists in the laboratory.

Benthic macroinvertebrate data from all study stations were compared to data from WC-1 which is classified as "F&W". Insufficient numbers of macroinvertebrates (<100 organisms) at some sampling stations limited the use of some metrics typically included in the RBP III protocol. However, metrics that were selected had good discriminatory capabilities based on box and whisker plots. One metric utilized for this comparison was the EPT Index. The EPT index is a summation of taxa within the insect orders Ephemeroptera (Mayflies), Plecoptera (Stoneflies), and Trichoptera (Caddisflies). Species within these orders are generally considered to be pollution-sensitive. Another metric utilized for comparison with WC-1 was the North Carolina Biotic Index (NCBI) adapted for Alabama (personal communication, Vicky Hulcher, ADEM 2000). The NCBI is based on pollution tolerance values for individual taxa. To calculate this metric the tolerance values for all organisms in a sample are summed and divided by the total number of individuals. Due to the low tolerance of siltation by certain Ephemeroptera, a metric was considered which calculated the % Ephemeroptera in each sample. The % Ephemeroptera metric, which did not discriminate among impaired sites as well as the EPT Index and the NCBI, was used as a secondary mode of comparison. Of all the metrics considered, the EPT Index and the NCBI were found to be the most sensitive and were utilized as the primary modes of comparison to WC-1. Secondary metrics used in this study were % Habitat comparability, % Dipterans, % Dominant taxon, % Clingers, % Ephemeroptera, and Taxa richness. These six metrics were used as a secondary mode of comparison. The habitat evaluation scores of the study stream stations were compared to WC-1. Habitat evaluation scores that were >80% of that for WC-1 were judged to be comparable and should be supportive of the water quality classification of "F&W".

***In situ* water quality-** In conjunction with the benthic macroinvertebrate bioassessment, measurements of pH, dissolved oxygen, conductivity, and water temperature were made with a calibrated Hydrolab Scout 2 water quality data system at all stream stations. These measurements served to identify any marked differences in water quality between WC-1 and the other stations. *In situ* water chemistry data was used for contrasting the study stream sites with WC-1. Instantaneous measurements of pH, dissolved oxygen, conductivity, and water temperature serve to identify water quality conditions which may affect aquatic life. In addition, such measurements may reveal exceedance(s) of state water quality standards.

QUALITY CONTROL/QUALITY ASSURANCE

The benthic macroinvertebrate sampling followed methods described in Rapid Bioassessment Protocols for Use in Streams and Rivers (U.S. EPA/841-B-99-002). The *in situ* water chemistry data were collected by methods described in Ecological Assessment Branch Standard Operating Procedures Manual (U.S. EPA, April 2000). Field instruments utilized for water quality measurements were calibrated at the beginning and end of each sampling day.

STUDY RESULTS

Biological data from the bioassessment were used to make comparisons between WC-1 and the other study stream stations. Specifically, the EPT Index, NCBI, and % Habitat comparability were the primary bases of comparison to WC-1. These three primary modes of comparison and the six secondary modes of comparison (% habitat comparability, % Dipterans, % Dominant taxon, % Clingers, % Ephemeroptera, and Taxa richness) comprised a weight of evidence approach for assessing whether the streams in the study area were meeting the F&W water quality classification. A summary of biological data is presented in Table 3 while Table 4 provides *in situ* water quality measurements taken during the study. Appendix A provides a list of benthic macroinvertebrates collected and identified at each sample station.

Benthic Macroinvertebrates- From 13 to 57 benthic macroinvertebrate taxa were collected at the study stations (Table 1). The EPT Index for study sites ranged from 3 to 15 compared to a 15 at WC-1, the reference site (Table 1). Habitat evaluations ranged from 118 to 180 and indicated degradation at HC-1, CC-2, and HC-4 (Table 1). All other study stations were similar in habitat to WC-1 and all had habitat scores greater than 80% of WC-1.

Land use maps were utilized to identify areas of present and past soil disturbing activities within the Hurricane Creek watershed (Figure 1). The land use maps showed the upper watershed, above study station HC- 4, to have little or no soil disturbing activities (Figure 1). The macroinvertebrate communities sampled in the upper watershed were good despite a slight decrease in habitat scores. Conductivity at HC- 4 (33.0 μ mhos/cm) was comparable to the reference site, WC-1 (45.4 μ mhos/cm; Table 2).

The land use map identified the middle portion of the watershed, study stations above HC-1 and below HC- 4, to have extensive past and present mining activities. The macroinvertebrate communities sampled in the middle section of the watershed were good with the exception of NFHT- 1 and KC- 2. The benthic community at NFHT-1 reflected the negative impacts of soil disturbing activities in the upper subwatershed of North Fork Hurricane Creek as identified by land use maps (Figure 1). At KC-2 Keeple Creek was a second order stream originating in an suburban area with an impoundment upstream. The benthic sample was dominated by the Isopod Lirceus sp. Conductivity measured at sample sites in the middle portion of the watershed except KC-1 and KC-2 were elevated in comparison to WC-1. Habitat evaluation scores from all study stations in the middle section of the watershed were good in comparison to WC- 1.

The land use maps identified the lower section of the watershed, from H-1 upstream to HC- 2, to have a moderate amount of soil disturbing activities. One feature in the lower watershed that was

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identified from land use maps was transitional areas near Hurricane Creek. These areas appeared as clearcuts and are possibly related to pre-mining land preparation (Figure 1). Since the land use maps are based on 1990 data these transitional areas may presently represent mining activity. Sampling stations in the lower portion of the watershed did not have good macroinvertebrate assemblages in comparison with the reference site, WC- 1. This portion of the watershed appears to be a point of attenuation of sediment and other contaminants from land disturbing activities upstream. As a result, macroinvertebrate communities in the lower watershed were impaired. Increased sedimentation in the lower watershed resulted in lower habitat evaluation scores for all stations compared to WC- 1, except CC-1. The latter station has a solid bedrock bottom which provided better habitat than did the other study stations in the lower watershed. All stations sampled in the lower portion of the watershed had elevated field conductivity readings compared to WC- 1 (Table 2).

***In situ* water quality-** Dissolved oxygen, pH, temperature, and conductivity measured at all stations met water quality standards for streams classified “F&W”. However, stations H-1, HC-1, HC-2, HC-3, HCRT-2, LHC-1, and NFHT-1 had elevated conductivity values compared to the reference station, WC-1 (Table 2).

CONCLUSIONS

Stations CC-1, CC-2, KC-2, H-1, HC-1, and NFHT-1 do not fully support the water quality classification of Fish & Wildlife compared to the reference site WC-1 based on the macroinvertebrate communities. The benthic macroinvertebrate data suggested impairment at study station KC-2. The benthic sample for KC-2 was dominated by the Isopod Lirceus sp. which prefer low flow or lentic environments, indicating a decreased flow regime at the sampling site. This may have resulted from impoundments upstream of the sample site. Eight EPT taxa were also collected at KC-2 which would indicate the stream has the potential to maintain a good and diverse macroinvertebrate community when stream flows are more consistent than they have been since the studies conducted by ADEM in 1996. The instream aquatic macroinvertebrate habitat at KC-2 was assessed as good when sampled in April, 2000. Since the surrounding land use associated with KC-2 is pasture and not mine related and flow is influenced by impoundments upstream, impairment at KC-2 is of a different nature than that identified at the other impaired sites. Due to drought conditions that have existed since 1997, water quality measurements such as conductivity and pH may have been underestimated during this study. In previous studies done by ADEM (1996 and 1997) field conductivity measurements were considerably higher than those measured in this study of the Hurricane Creek watershed (personal communication, Vicky Hulcher, ADEM 2000).

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Table 1. Sampling stations used in bioassessment of Hurricane Creek, AL. By U.S. EPA, April 2000.

STATION	LAT/LONG	OTHER AGENCIES USE
H-1- Hurricane Creek at CR 88	W 87° 27' 44.1" N 33° 13' 46.7"	ADEM monitoring station
HC-1 - Hurricane Creek at CR 216	W 87° 26' 50.3"N 33° 12' 38.3"	GSA monitoring station
CC-1 - Cottondale Creek at CR 32	W 87° 26' 49.2"N 33° 12' 00.8"	new station
CC-2 - Cottondale Creek at CR 77	W 87° 26' 33.5"N 33° 10' 57.5"	new station
HC-2 - Hurricane Creek below Kepple Creek	W 87° 21' 32.7"N 33° 12' 30.8"	GSA monitoring station
KC-1 - Kepple Creek above Hurricane Creek	W 87° 21' 28.2"N 33° 12' 27.9"	GSA monitoring station
KC-2 - Kepple Creek at U.S. 11	W 87° 21' 08.0"N 33° 10' 30.3"	GSA station & ADEM multi-habitat
HC-3 - Hurricane Creek above Kepple Creek	W 87° 21' 29.9"N 33° 12' 32.6"	GSA monitoring station
LHC-1 - Little Hurricane Creek above Hurricane Creek	W 87° 19' 52.3"N 33° 12' 50.0"	GSA monitoring station
LHC-3 - Little Hurricane Creek at U.S. 11	W 87° 18' 30.0"N 33° 10' 33.6"	GSA station & ADEM multi-habitat
HCRT-2 - Hurricane Creek at CR 59	W 87° 18' 54.6"N 33° 13' 16.7"	ADEM multi-habitat
NFHT-1 - North Fork Hurricane Creek upstream of Hurricane Creek	W 87° 18' 25.5"N 33° 13' 26.5"	ADEM EPT Screening station
HC-4 Hurricane Creek approximately 2 miles upstream of CR 59	W 87° 17' 38.4"N 33° 12' 37.3"	GSA station & ADEM water chemistry station

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WC-1 - Wolf Creek (Walker County, northwest of Jasper, AL) at Hwy.102	W 87° 29' 34.2"N 33° 47' 52.9	reference site
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Table 2. Comparison of ADEM 1996 and 1997 macroinvertebrate data to U.S. EPA macroinvertebrate data collected in 2000.

1996 and 1997 ADEM Macroinvertebrate Data					2000 U.S. EPA Macroinvertebrate Data				
Station	# EPT	Habitat	Conductivity	Rating	Station	# EPT	Habitat	Conductivity	Rating
NFHT-1 1997	3	good/fair	1528 µmhos/cm	severely impaired	NFHT-1	4	good	700 µmhos/cm	impaired
HCRT-2 1996	8	good	1697 µmhos/cm	slightly impaired	HCRT-2	12	good	424 µmhos/cm	good
HCRT-3 1996	8	good	624 µmhos/cm	slightly impaired	HC-2 (same as HCRT-3)	12	good	284 µmhos/cm	good
H-1 1996	7	good	579 µmhos/cm	moderately impaired	H-1	8	good/fair	221 µmhos/cm	impaired

Table 3 . Hurricane Creek, April 2000: Summary of biological data collected by U.S. EPA.

Station	Stream	Date	% Ephem.	Habitat score (200 max.)	Taxa Richness	EPT Index	NCBI (adapted for Alabama)	% Diptera	% Dom. Taxon	% Clingers	Biology Rating
CC-1	Cottdondale	4/25/00	0	173	30	3	6.00	57	19	35	impaired
CC-2	Cottdondale	4/25/00	2.9	130	32	5	5.84	39	30	56	impaired
H-1	Hurricane	4/25/00	14	138	25	8	5.98	21	12	44	impaired
HC-1	Hurricane	4/25/00	4	118	36	12	7.12	7	33	27	impaired
HC-2	Hurricane	4/25/00	15.5	180	34	12	5.34	21	12	41	good
HC-3	Hurricane	4/25/00	3.8	172	30	11	4.98	17	11	60	good
HC-4	Hurricane	4/26/00	42	132	57	15	5.20	28	14	55	good
HCRT-2	Hurricane	4/25/00	52	166	36	12	5.31	11	15	60	good
KC-1	Kepple	4/25/00	5.1	170	30	9	5.24	63	29	56	fair

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KC-2	Kepple	4/26/00	3	161	42	8	7.56	6	84	7	impaired
LHC-1	Little Hurricane	4/25/00	18.5	176	36	14	5.59	37	8	34	good
LHC-3	Little Hurricane	4/25/00	6.8	179	40	12	5.14	73	21	27	good
NFHT-1	North Fork Hurricane	4/25/00	4	163	13	4	6.90	16	28	36	impaired
WC-1	Wolf	4/24/00	23.7	167	29	15	4.38	3	27	74	excellent

Table 4. *In situ* water quality measurements at Hurricane, Little Hurricane, Kepple, and Cottondale Creeks, Tuscaloosa, Alabama. April 2000.

Site	Date	pH	Dissolved Oxygen (mg/L)	Water Temperature (°C)	Conductivity (µmhos/cm)
H-1	4/25/00	7.53	7.58	15.6	221
HC-1	4/25/00	7.41	7.74	16.8	237
CC-1	4/25/00	7.48	6.86	17.7	90.8
CC-2	4/25/00	7.09	6.82	17.8	91.8
HC-4	4/26/00	7.59	9.87	13.44	33.0
KC-2	4/26/00	6.97	9.33	17.05	58.0
LHC-1	4/25/00	7.20	8.68	14.79	357
LHC-3	4/25/00	7.22	8.41	15.42	93.7
HC-2	4/25/00	7.26	8.57	17.24	284
HC-3	4/25/00	7.31	8.59	17.49	308
KC-1	4/25/00	6.83	8.55	17.55	90.5
HCRT-2	4/25/00	7.29	8.36	17.69	424
NFHT-1	4/25/00	7.48	8.11	18.11	700
WC-1	4/24/00	7.83	8.45	15.8	45.4

Appendix C: Sub Watershed Information**Baseline Loading by Sub Watershed**

Sub	ALUMINUM	FECAL	IRON	Sediment
Watershed	(#/year)	(#/year)	(#/year)	(#/year)
1	1882	1035363	1338	85
10	7165	11879166	4917	159
11	2136	3644855	1490	38
12	5423	6034467	3778	93
13	6334	40899210	4424	378
14	4178	25195662	2951	263
15	3768	60023167	2699	310
16	4988	68834404	3597	423
17	1038	17327116	744	83
18	7286	35776258	5130	461
19	6945	67150051	4918	493
2	6567	2872765	4704	34
20	16088	2356369	11532	73
21	23948	1856323	17178	97
22	13601	819619	9562	269
23	8427	513662	5906	128
24	449	22668	314	11
25	15344	3473543	11004	77
26	8738	1738474	6126	141
27	456	2833095	319	8
28	9374	7427889	6567	131
29	6878	85556019	4827	197
3	476	3157840	343	38
30	11850	105045133	8341	466
31	3971	127108071	2806	287
32	1503	18098278	1057	44
33	742	558840	534	60
34	1178	2339989	849	93
35	2991	4168803	2093	155
36	647	525242	462	45
37	15016	3133927	10783	54
38	2824	1925354	1982	65
39	2972	8961915	2121	198
4	1581	4389317	1112	97
40	210	124543	152	18
41	5790	17297109	4094	319
42	2957	17379054	2111	227
43	949	6976369	676	74
44	1514	6090704	1077	18
45	965	2848091	687	12
46	75	15185	55	7
47	1664	3508872	1196	17
48	3616	3025581	2581	40

49	4278	146227613	3070	379
5	2319	4595674	1644	25
50	944	864989	672	44
51	3045	2374405	2141	76
52	131	539262	97	13
53	1582	627152	1128	91
54	864	6052187	611	37
55	14854	12044175	10433	296
56	1259	498978	918	106
57	1263	212389	902	57
58	22812	6132987	15971	299
59	266	289366	191	14
6	273	55304	199	24
60	26329	5512680	18475	440
61	123	196033	91	12
62	679	217332	493	59
63	126	27234	92	12
64	834	332481	607	72
65	5037	523850	3555	124
66	5348	10712482	3776	180
67	1652	1868601	1203	148
68	949	452324	693	86
69	3792	14127950	2748	326
7	5742	12619524	3953	118
70	746	737776	539	62
71	3849	855731	2820	25
72	2813	4178964	2042	24
8	2201	5655446	1554	94
9	332	2777055	236	23

Total 338949 1025258304 239989 9554

Baseline Loading by Land Use and Sub Watershed

Sub Watershed	Land Use	Aluminum	Iron	Fecal Coliform	Sediment
	Type	(#/Year)	(#/Year)	(#/Year)	(#/Year)
1	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
10	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
11	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
12	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
13	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
14	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
15	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
16	ABANDON MINE	0.0	0.0	0.0	0.0

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	LANDS				
17	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
18	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
19	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
2	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
20	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
21	ABANDON MINE LANDS	1,095.5	789.0	14,615.7	2.9
22	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
23	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
24	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
25	ABANDON MINE LANDS	359.9	259.3	4,802.3	1.0
26	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
27	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
28	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
29	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
3	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
30	ABANDON MINE LANDS	443.1	310.8	8,987.8	4.5
31	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
32	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
33	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
34	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
35	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
36	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
37	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
38	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
39	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
4	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
40	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
41	ABANDON MINE LANDS	354.5	248.7	7,190.3	3.6

	LANDS				
42	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
43	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
44	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
45	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
46	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
47	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
48	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
49	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
5	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
50	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
51	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
52	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
53	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
54	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
55	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
56	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
57	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
58	ABANDON MINE LANDS	3,390.1	2,377.8	68,757.1	34.4
59	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
6	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
60	ABANDON MINE LANDS	6,270.5	4,398.2	127,177.2	63.6
61	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
62	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
63	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
64	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
65	ABANDON MINE LANDS	4,077.0	2,859.6	82,687.4	41.3
66	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
67	ABANDON MINE LANDS	0.0	0.0	0.0	0.0

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68	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
69	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
7	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
70	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
71	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
72	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
8	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
9	ABANDON MINE LANDS	0.0	0.0	0.0	0.0
	Subtotal	15,990.6	11,243.5	314,217.8	151.2
1	Barren	41.6	28.5	2,338.3	1.2
10	Barren	18.5	12.9	887.7	0.2
11	Barren	0.9	0.6	43.9	0.0
12	Barren	70.1	48.9	3,371.3	0.7
13	Barren	117.8	80.7	6,620.8	3.4
14	Barren	41.6	28.5	2,338.3	1.2
15	Barren	265.2	181.6	14,901.3	7.7
16	Barren	13.9	9.5	779.4	0.4
17	Barren	1.7	1.2	96.3	0.1
18	Barren	1,019.0	697.7	57,262.3	29.8
19	Barren	83.2	57.0	4,676.7	2.4
2	Barren	4.6	3.2	221.4	0.0
20	Barren	619.0	431.8	29,769.7	6.3
21	Barren	46.1	32.2	2,218.3	0.5
22	Barren	48.5	33.2	2,728.0	1.4
23	Barren	81.4	55.8	4,575.9	2.4
24	Barren	60.6	41.5	3,406.8	1.8
25	Barren	19.4	13.5	931.6	0.2
26	Barren	338.0	231.4	18,991.2	9.9
27	Barren	0.0	0.0	0.0	0.0
28	Barren	86.7	59.3	4,869.3	2.5
29	Barren	0.0	0.0	0.0	0.0
3	Barren	10.4	7.1	582.4	0.3
30	Barren	915.1	626.5	51,421.0	26.7
31	Barren	20.8	14.2	1,169.2	0.6
32	Barren	0.0	0.0	0.0	0.0
33	Barren	0.0	0.0	0.0	0.0
34	Barren	0.0	0.0	0.0	0.0
35	Barren	1,622.2	1,110.7	91,154.9	47.4
36	Barren	216.6	148.3	12,173.2	6.3
37	Barren	1.8	1.3	87.8	0.0
38	Barren	67.6	46.3	3,796.5	2.0
39	Barren	370.8	253.9	20,838.9	10.8
4	Barren	46.8	32.0	2,627.3	1.4

40	Barren	0.0	0.0	0.0	0.0
41	Barren	43.3	29.7	2,434.6	1.3
42	Barren	0.0	0.0	0.0	0.0
43	Barren	0.0	0.0	0.0	0.0
44	Barren	0.0	0.0	0.0	0.0
45	Barren	0.0	0.0	0.0	0.0
46	Barren	0.0	0.0	0.0	0.0
47	Barren	0.0	0.0	0.0	0.0
48	Barren	4.6	3.2	221.4	0.0
49	Barren	8.6	5.9	486.1	0.3
5	Barren	0.9	0.6	43.9	0.0
50	Barren	17.3	11.8	972.1	0.5
51	Barren	0.0	0.0	0.0	0.0
52	Barren	0.0	0.0	0.0	0.0
53	Barren	6.9	4.7	389.7	0.2
54	Barren	0.0	0.0	0.0	0.0
55	Barren	173.3	118.7	9,738.6	5.1
56	Barren	3.4	2.3	192.7	0.1
57	Barren	1.7	1.2	96.3	0.1
58	Barren	0.0	0.0	0.0	0.0
59	Barren	0.0	0.0	0.0	0.0
6	Barren	0.0	0.0	0.0	0.0
60	Barren	0.0	0.0	0.0	0.0
61	Barren	0.0	0.0	0.0	0.0
62	Barren	1.7	1.2	96.3	0.1
63	Barren	3.4	2.3	192.7	0.1
64	Barren	0.0	0.0	0.0	0.0
65	Barren	0.0	0.0	0.0	0.0
66	Barren	182.0	124.6	10,224.5	5.3
67	Barren	3.4	2.3	192.7	0.1
68	Barren	0.0	0.0	0.0	0.0
69	Barren	0.0	0.0	0.0	0.0
7	Barren	37.8	26.4	1,819.3	0.4
70	Barren	15.6	10.7	875.8	0.5
71	Barren	2.8	1.9	133.7	0.0
72	Barren	0.0	0.0	0.0	0.0
8	Barren	24.2	16.6	1,361.8	0.7
9	Barren	52.0	35.6	2,920.7	1.5
	Subtotal	6,833.0	4,689.0	377,273.0	183.7
1	Cropland	23.8	17.5	5,465.8	4.3
10	Cropland	76.9	56.9	5,725.7	0.9
11	Cropland	16.3	12.1	1,213.5	0.2
12	Cropland	169.5	125.4	12,624.8	1.9
13	Cropland	15.1	11.1	3,477.0	2.7
14	Cropland	132.9	97.7	30,515.3	23.9
15	Cropland	304.0	223.4	69,773.3	54.6
16	Cropland	194.0	142.6	44,526.3	34.9
17	Cropland	38.5	28.3	8,844.6	6.9
18	Cropland	112.6	82.7	25,840.9	20.2
19	Cropland	245.1	180.1	56,258.3	44.0

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2	Cropland	40.5	30.0	3,014.8	0.5
20	Cropland	52.2	38.6	3,884.4	0.6
21	Cropland	72.0	53.3	5,361.7	0.8
22	Cropland	6.5	4.8	1,492.7	1.2
23	Cropland	3.9	2.9	893.8	0.7
24	Cropland	0.0	0.0	0.0	0.0
25	Cropland	61.1	45.2	4,552.2	0.7
26	Cropland	0.4	0.3	98.3	0.1
27	Cropland	1.3	1.0	299.4	0.2
28	Cropland	9.1	6.7	2,087.1	1.6
29	Cropland	68.8	50.6	15,803.0	12.4
3	Cropland	6.5	4.8	1,492.7	1.2
30	Cropland	297.9	219.0	68,383.4	53.5
31	Cropland	310.5	228.2	71,266.0	55.8
32	Cropland	7.4	5.4	1,689.4	1.3
33	Cropland	4.8	3.5	1,095.0	0.9
34	Cropland	12.6	9.2	2,882.6	2.3
35	Cropland	17.8	13.1	4,075.9	3.2
36	Cropland	2.2	1.6	496.1	0.4
37	Cropland	7.6	5.6	566.8	0.1
38	Cropland	3.5	2.5	795.5	0.6
39	Cropland	44.2	32.5	10,136.1	7.9
4	Cropland	24.7	18.1	5,666.9	4.4
40	Cropland	2.2	1.6	496.1	0.4
41	Cropland	148.5	109.2	34,091.0	26.7
42	Cropland	82.3	60.5	18,886.9	14.8
43	Cropland	61.9	45.5	14,212.0	11.1
44	Cropland	60.3	44.6	4,491.2	0.7
45	Cropland	42.1	31.2	3,135.7	0.5
46	Cropland	3.0	2.2	697.2	0.5
47	Cropland	66.8	49.5	4,976.9	0.7
48	Cropland	39.7	29.3	2,953.8	0.4
49	Cropland	585.9	430.6	134,482.3	105.3
5	Cropland	86.1	63.7	6,413.4	1.0
50	Cropland	3.5	2.5	795.5	0.6
51	Cropland	17.8	13.1	4,075.9	3.2
52	Cropland	2.2	1.6	496.1	0.4
53	Cropland	3.0	2.2	697.2	0.5
54	Cropland	2.6	1.9	594.4	0.5
55	Cropland	50.2	36.9	11,530.5	9.0
56	Cropland	6.1	4.5	1,389.9	1.1
57	Cropland	3.9	2.9	893.8	0.7
58	Cropland	1.7	1.3	397.8	0.3
59	Cropland	0.0	0.0	0.0	0.0
6	Cropland	0.0	0.0	0.0	0.0
60	Cropland	3.9	2.9	893.8	0.7
61	Cropland	0.0	0.0	0.0	0.0
62	Cropland	0.0	0.0	0.0	0.0
63	Cropland	0.4	0.3	98.3	0.1

64	Cropland	1.3	1.0	299.4	0.2
65	Cropland	12.1	8.9	2,784.3	2.2
66	Cropland	17.8	13.1	4,075.9	3.2
67	Cropland	12.6	9.2	2,882.6	2.3
68	Cropland	2.2	1.6	496.1	0.4
69	Cropland	30.7	22.6	7,056.9	5.5
7	Cropland	50.2	37.2	3,742.5	0.6
70	Cropland	1.3	1.0	299.4	0.2
71	Cropland	17.1	12.7	1,274.5	0.2
72	Cropland	29.9	22.1	2,225.2	0.3
8	Cropland	5.2	3.8	1,193.3	0.9
9	Cropland	10.8	8.0	2,484.8	1.9
	Subtotal	3,849.1	2,833.6	745,813.7	542.0
1	Dirtroad	26.9	18.1	1,037.2	0.5
10	Dirtroad	43.2	29.3	1,682.1	0.4
11	Dirtroad	21.6	14.6	841.1	0.2
12	Dirtroad	39.8	27.0	1,549.3	0.4
13	Dirtroad	101.4	68.3	3,909.5	1.9
14	Dirtroad	74.5	50.2	2,872.3	1.4
15	Dirtroad	93.1	62.7	3,590.4	1.7
16	Dirtroad	138.7	93.4	5,345.6	2.6
17	Dirtroad	26.9	18.1	1,037.2	0.5
18	Dirtroad	136.6	92.0	5,265.9	2.5
19	Dirtroad	146.9	99.0	5,664.8	2.7
2	Dirtroad	28.4	19.3	1,106.7	0.3
20	Dirtroad	56.8	38.5	2,213.4	0.5
21	Dirtroad	63.6	43.2	2,478.9	0.6
22	Dirtroad	74.5	50.2	2,872.3	1.4
23	Dirtroad	31.0	20.9	1,196.8	0.6
24	Dirtroad	2.1	1.4	79.8	0.0
25	Dirtroad	70.4	47.8	2,744.5	0.7
26	Dirtroad	35.2	23.7	1,356.4	0.7
27	Dirtroad	2.1	1.4	79.8	0.0
28	Dirtroad	29.0	19.5	1,117.0	0.5
29	Dirtroad	53.8	36.2	2,074.5	1.0
3	Dirtroad	12.4	8.4	478.7	0.2
30	Dirtroad	130.4	87.8	5,026.5	2.4
31	Dirtroad	78.6	53.0	3,031.9	1.5
32	Dirtroad	12.4	8.4	478.7	0.2
33	Dirtroad	20.7	13.9	797.9	0.4
34	Dirtroad	31.0	20.9	1,196.8	0.6
35	Dirtroad	45.5	30.7	1,755.3	0.8
36	Dirtroad	14.5	9.8	558.5	0.3
37	Dirtroad	35.2	23.9	1,372.3	0.3
38	Dirtroad	16.6	11.2	638.3	0.3
39	Dirtroad	64.2	43.2	2,473.4	1.2
4	Dirtroad	29.0	19.5	1,117.0	0.5
40	Dirtroad	6.2	4.2	239.4	0.1
41	Dirtroad	93.1	62.7	3,590.4	1.7
42	Dirtroad	72.4	48.8	2,792.5	1.3

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43	Dirtroad	22.8	15.3	877.6	0.4
44	Dirtroad	21.6	14.6	841.1	0.2
45	Dirtroad	14.8	10.0	575.5	0.1
46	Dirtroad	2.1	1.4	79.8	0.0
47	Dirtroad	28.4	19.3	1,106.7	0.3
48	Dirtroad	55.7	37.8	2,169.1	0.5
49	Dirtroad	107.6	72.5	4,148.9	2.0
5	Dirtroad	25.0	17.0	973.9	0.2
50	Dirtroad	14.5	9.8	558.5	0.3
51	Dirtroad	20.7	13.9	797.9	0.4
52	Dirtroad	4.1	2.8	159.6	0.1
53	Dirtroad	31.0	20.9	1,196.8	0.6
54	Dirtroad	10.3	7.0	398.9	0.2
55	Dirtroad	78.6	53.0	3,031.9	1.5
56	Dirtroad	39.3	26.5	1,515.9	0.7
57	Dirtroad	20.7	13.9	797.9	0.4
58	Dirtroad	64.2	43.2	2,473.4	1.2
59	Dirtroad	4.1	2.8	159.6	0.1
6	Dirtroad	8.3	5.6	319.1	0.2
60	Dirtroad	111.7	75.3	4,308.5	2.1
61	Dirtroad	4.1	2.8	159.6	0.1
62	Dirtroad	20.7	13.9	797.9	0.4
63	Dirtroad	4.1	2.8	159.6	0.1
64	Dirtroad	26.9	18.1	1,037.2	0.5
65	Dirtroad	37.2	25.1	1,436.2	0.7
66	Dirtroad	55.9	37.6	2,154.2	1.0
67	Dirtroad	53.8	36.2	2,074.5	1.0
68	Dirtroad	31.0	20.9	1,196.8	0.6
69	Dirtroad	113.8	76.7	4,388.3	2.1
7	Dirtroad	38.6	26.2	1,505.1	0.4
70	Dirtroad	22.8	15.3	877.6	0.4
71	Dirtroad	75.0	50.9	2,921.6	0.7
72	Dirtroad	54.5	37.0	2,124.8	0.5
8	Dirtroad	29.0	19.5	1,117.0	0.5
9	Dirtroad	6.2	4.2	239.4	0.1
	Subtotal	3,217.9	2,170.7	124,343.0	53.4
1	Forest	586.4	433.3	133,293.4	58.7
10	Forest	862.8	643.5	41,526.6	3.5
11	Forest	603.5	450.1	29,048.1	2.5
12	Forest	912.0	680.2	43,894.4	3.7
13	Forest	1,959.2	1,447.7	445,369.1	196.0
14	Forest	1,428.5	1,055.5	324,723.3	142.9
15	Forest	1,791.0	1,323.4	407,143.3	179.2
16	Forest	3,004.8	2,220.3	683,057.0	300.6
17	Forest	550.8	407.0	125,219.3	55.1
18	Forest	2,866.5	2,118.1	651,609.7	286.8
19	Forest	3,041.7	2,247.6	691,449.9	304.3
2	Forest	612.7	457.0	29,487.6	2.5
20	Forest	967.9	721.9	46,583.8	4.0

21	Forest	831.5	620.2	40,021.9	3.4
22	Forest	1,134.7	838.4	257,938.3	113.5
23	Forest	282.6	208.8	64,251.1	28.3
24	Forest	44.1	32.6	10,026.2	4.4
25	Forest	1,661.9	1,239.5	79,988.7	6.8
26	Forest	359.2	265.4	81,656.6	35.9
27	Forest	17.6	13.0	4,011.1	1.8
28	Forest	183.1	135.3	41,618.7	18.3
29	Forest	628.2	464.1	142,794.0	62.8
3	Forest	301.7	222.9	68,588.7	30.2
30	Forest	2,086.3	1,541.6	474,269.2	208.7
31	Forest	1,203.1	889.0	273,498.6	120.4
32	Forest	179.4	132.6	40,790.1	18.0
33	Forest	490.1	362.2	111,416.8	49.0
34	Forest	763.0	563.8	173,441.4	76.3
35	Forest	831.9	614.7	189,121.0	83.2
36	Forest	333.8	246.6	75,879.4	33.4
37	Forest	335.9	250.5	16,165.5	1.4
38	Forest	278.2	205.5	63,233.9	27.8
39	Forest	1,429.0	1,055.9	324,842.3	143.0
4	Forest	588.5	434.9	133,786.5	58.9
40	Forest	151.4	111.9	34,419.1	15.1
41	Forest	1,977.1	1,460.9	449,438.5	197.8
42	Forest	1,599.7	1,182.0	363,651.4	160.0
43	Forest	461.0	340.6	104,794.8	46.1
44	Forest	619.4	462.0	29,812.3	2.5
45	Forest	417.3	311.2	20,082.6	1.7
46	Forest	56.5	41.8	12,846.5	5.7
47	Forest	881.2	657.2	42,412.4	3.6
48	Forest	1,858.6	1,386.2	89,455.0	7.6
49	Forest	1,707.8	1,261.9	388,226.4	170.8
5	Forest	721.5	538.2	34,728.8	3.0
50	Forest	324.3	239.6	73,711.2	32.4
51	Forest	356.1	263.1	80,937.8	35.6
52	Forest	112.2	82.9	25,507.4	11.2
53	Forest	710.7	525.1	161,549.9	71.1
54	Forest	227.5	168.1	51,712.4	22.8
55	Forest	1,088.3	804.2	247,402.9	108.9
56	Forest	940.0	694.6	213,692.4	94.0
57	Forest	440.4	325.4	100,104.5	44.1
58	Forest	285.9	211.3	64,991.3	28.6
59	Forest	116.7	86.3	26,536.8	11.7
6	Forest	212.8	157.2	48,371.0	21.3
60	Forest	1,370.9	1,013.0	311,641.0	137.1
61	Forest	108.2	79.9	24,587.7	10.8
62	Forest	515.5	380.9	117,190.2	51.6
63	Forest	107.6	79.5	24,453.7	10.8
64	Forest	636.0	469.9	144,569.3	63.6
65	Forest	675.3	499.0	153,512.5	67.6
66	Forest	1,080.5	798.4	245,632.0	108.1

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67	Forest	1,284.3	949.0	291,948.1	128.5
68	Forest	765.6	565.7	174,044.3	76.6
69	Forest	2,735.5	2,021.3	621,833.9	273.7
7	Forest	761.1	567.7	36,632.9	3.1
70	Forest	528.6	390.6	120,157.7	52.9
71	Forest	2,647.8	1,974.9	127,440.2	10.8
72	Forest	1,850.3	1,380.1	89,058.5	7.6
8	Forest	586.4	433.3	133,293.4	58.7
9	Forest	147.5	109.0	33,538.9	14.8
	Subtotal	64,219.3	47,567.2	11,633,665.5	4,836.9
1	Hardwoods	62.6	45.0	14,223.8	5.2
10	Hardwoods	137.7	100.4	17,716.4	2.8
11	Hardwoods	66.5	48.5	8,554.5	1.3
12	Hardwoods	124.8	90.9	16,052.8	2.5
13	Hardwoods	231.0	166.0	52,480.9	19.2
14	Hardwoods	171.6	123.3	38,992.8	14.3
15	Hardwoods	212.7	152.8	48,311.8	17.7
16	Hardwoods	317.9	228.4	72,223.2	26.5
17	Hardwoods	60.5	43.4	13,733.4	5.0
18	Hardwoods	311.7	223.9	70,812.9	26.0
19	Hardwoods	333.6	239.6	75,778.8	27.8
2	Hardwoods	90.5	66.0	11,643.5	1.8
20	Hardwoods	180.2	131.3	23,181.6	3.6
21	Hardwoods	200.9	146.4	25,848.3	4.0
22	Hardwoods	168.9	121.4	38,379.8	14.1
23	Hardwoods	68.5	49.2	15,572.7	5.7
24	Hardwoods	6.5	4.7	1,471.4	0.5
25	Hardwoods	223.2	162.7	28,726.3	4.5
26	Hardwoods	79.9	57.4	18,147.7	6.7
27	Hardwoods	4.6	3.3	1,042.3	0.4
28	Hardwoods	67.5	48.5	15,327.4	5.6
29	Hardwoods	120.9	86.9	27,466.9	10.1
3	Hardwoods	29.7	21.3	6,744.1	2.5
30	Hardwoods	297.4	213.6	67,563.3	24.8
31	Hardwoods	178.1	128.0	40,464.1	14.8
32	Hardwoods	28.6	20.6	6,498.8	2.4
33	Hardwoods	46.4	33.3	10,545.2	3.9
34	Hardwoods	72.9	52.3	16,553.6	6.1
35	Hardwoods	105.8	76.0	24,033.3	8.8
36	Hardwoods	34.5	24.8	7,847.6	2.9
37	Hardwoods	111.2	81.1	14,310.3	2.2
38	Hardwoods	39.9	28.7	9,073.9	3.3
39	Hardwoods	147.4	105.9	33,475.1	12.3
4	Hardwoods	64.2	46.1	14,591.7	5.3
40	Hardwoods	14.0	10.1	3,188.1	1.2
41	Hardwoods	213.5	153.4	48,495.8	17.8
42	Hardwoods	164.1	117.9	37,276.4	13.7
43	Hardwoods	49.9	35.9	11,342.3	4.2
44	Hardwoods	69.4	50.6	8,924.2	1.4

45	Hardwoods	45.1	32.9	5,808.6	0.9
46	Hardwoods	5.4	3.9	1,226.2	0.4
47	Hardwoods	88.4	64.5	11,379.5	1.8
48	Hardwoods	174.6	127.3	22,468.7	3.5
49	Hardwoods	245.1	176.0	55,669.2	20.4
5	Hardwoods	80.4	58.6	10,349.9	1.6
50	Hardwoods	33.7	24.2	7,663.7	2.8
51	Hardwoods	47.8	34.3	10,851.8	4.0
52	Hardwoods	10.5	7.6	2,391.1	0.9
53	Hardwoods	69.4	49.8	15,756.6	5.8
54	Hardwoods	25.9	18.6	5,885.7	2.2
55	Hardwoods	178.9	128.5	40,647.9	14.9
56	Hardwoods	88.0	63.2	19,986.9	7.3
57	Hardwoods	44.8	32.2	10,177.3	3.7
58	Hardwoods	145.2	104.3	32,984.6	12.1
59	Hardwoods	11.6	8.3	2,636.3	1.0
6	Hardwoods	20.0	14.3	4,536.9	1.7
60	Hardwoods	256.7	184.4	58,305.4	21.4
61	Hardwoods	10.3	7.4	2,329.8	0.9
62	Hardwoods	48.0	34.5	10,913.1	4.0
63	Hardwoods	10.3	7.4	2,329.8	0.9
64	Hardwoods	59.4	42.7	13,488.2	4.9
65	Hardwoods	86.4	62.0	19,619.1	7.2
66	Hardwoods	126.3	90.7	28,693.0	10.5
67	Hardwoods	120.6	86.7	27,405.5	10.0
68	Hardwoods	71.2	51.2	16,185.7	5.9
69	Hardwoods	260.7	187.3	59,225.2	21.7
7	Hardwoods	123.1	89.7	15,841.7	2.5
70	Hardwoods	49.9	35.9	11,342.3	4.2
71	Hardwoods	238.0	173.5	30,627.3	4.8
72	Hardwoods	171.7	125.2	22,099.0	3.5
8	Hardwoods	65.3	46.9	14,836.9	5.4
9	Hardwoods	16.2	11.6	3,678.6	1.3
	Subtotal	7,938.1	5,725.1	1,593,958.1	526.7
1	Pasture	4.1	2.9	852,458.9	0.3
10	Pasture	208.6	154.2	11,469,914.3	1.2
11	Pasture	64.2	47.5	3,530,388.9	0.4
12	Pasture	104.8	77.5	5,764,762.9	0.6
13	Pasture	192.6	138.7	40,138,528.0	14.8
14	Pasture	118.4	85.3	24,679,060.6	9.1
15	Pasture	285.3	205.4	59,437,860.6	21.9
16	Pasture	326.2	234.9	67,977,792.0	25.1
17	Pasture	82.4	59.3	17,164,347.4	6.3
18	Pasture	167.2	120.4	34,843,300.6	12.9
19	Pasture	317.6	228.7	66,184,612.6	24.4
2	Pasture	49.6	36.6	2,725,984.0	0.3
20	Pasture	36.8	27.2	2,026,064.3	0.2
21	Pasture	26.0	19.2	1,429,970.3	0.1
22	Pasture	1.2	0.9	257,273.6	0.1
23	Pasture	1.2	0.9	257,273.6	0.1

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24	Pasture	0.0	0.0	0.0	0.0
25	Pasture	56.9	42.1	3,127,848.9	0.3
26	Pasture	7.0	5.0	1,451,483.6	0.5
27	Pasture	13.5	9.7	2,818,485.7	1.0
28	Pasture	34.4	24.8	7,172,945.1	2.6
29	Pasture	409.0	294.5	85,226,706.3	31.4
3	Pasture	14.8	10.6	3,075,761.1	1.1
30	Pasture	500.0	360.0	104,184,192.0	38.4
31	Pasture	607.8	437.6	126,647,862.9	46.7
32	Pasture	86.5	62.3	18,020,641.1	6.6
33	Pasture	2.0	1.5	426,229.4	0.2
34	Pasture	10.2	7.4	2,134,986.3	0.8
35	Pasture	18.4	13.3	3,843,742.6	1.4
36	Pasture	2.0	1.5	426,229.4	0.2
37	Pasture	52.5	38.8	2,889,413.1	0.3
38	Pasture	8.6	6.2	1,793,236.3	0.7
39	Pasture	41.0	29.5	8,539,945.1	3.2
4	Pasture	20.1	14.5	4,185,497.4	1.5
40	Pasture	0.4	0.3	84,477.8	0.0
41	Pasture	79.9	57.5	16,653,682.3	6.1
42	Pasture	81.2	58.4	16,910,950.9	6.2
43	Pasture	32.8	23.6	6,831,182.3	2.5
44	Pasture	109.4	80.9	6,017,932.6	0.6
45	Pasture	50.9	37.6	2,800,332.6	0.3
46	Pasture	0.0	0.0	0.0	0.0
47	Pasture	62.3	46.1	3,425,900.9	0.4
48	Pasture	51.7	38.3	2,845,207.4	0.3
49	Pasture	698.8	503.2	145,605,156.6	53.7
5	Pasture	81.8	60.5	4,498,224.6	0.5
50	Pasture	3.7	2.7	767,979.8	0.3
51	Pasture	10.7	7.7	2,219,461.6	0.8
52	Pasture	2.5	1.8	510,708.0	0.2
53	Pasture	2.0	1.5	426,229.4	0.2
54	Pasture	28.7	20.7	5,978,728.6	2.2
55	Pasture	54.9	39.5	11,442,914.3	4.2
56	Pasture	1.2	0.9	257,273.6	0.1
57	Pasture	0.4	0.3	84,477.8	0.0
58	Pasture	26.6	19.2	5,548,669.7	2.0
59	Pasture	1.2	0.9	257,273.6	0.1
6	Pasture	0.0	0.0	0.0	0.0
60	Pasture	22.1	15.9	4,611,723.4	1.7
61	Pasture	0.8	0.6	168,955.7	0.1
62	Pasture	0.4	0.3	84,477.8	0.0
63	Pasture	0.0	0.0	0.0	0.0
64	Pasture	0.8	0.6	168,955.7	0.1
65	Pasture	1.2	0.9	257,273.6	0.1
66	Pasture	49.6	35.7	10,333,176.0	3.8
67	Pasture	7.4	5.3	1,535,959.6	0.6
68	Pasture	1.2	0.9	257,273.6	0.1

69	Pasture	64.4	46.3	13,408,934.9	4.9
7	Pasture	223.7	165.4	12,303,787.4	1.3
70	Pasture	2.9	2.1	599,024.8	0.2
71	Pasture	12.2	9.0	670,443.6	0.1
72	Pasture	73.4	54.3	4,036,719.7	0.4
8	Pasture	26.2	18.9	5,464,178.3	2.0
9	Pasture	13.1	9.4	2,730,168.9	1.0
	Subtotal	5,752.0	4,166.0	#####	352.1
1	Paveroad	80.6	54.1	3,353.6	2.3
10	Paveroad	2,751.1	1,841.0	115,013.3	50.7
11	Paveroad	818.1	547.5	34,202.2	15.1
12	Paveroad	1,772.6	1,186.2	74,104.9	32.7
13	Paveroad	1,442.9	968.0	60,028.8	40.9
14	Paveroad	1,056.0	708.4	43,931.9	29.9
15	Paveroad	632.8	424.5	26,325.5	17.9
16	Paveroad	806.1	540.8	33,535.7	22.8
17	Paveroad	221.7	148.7	9,222.3	6.3
18	Paveroad	2,365.9	1,587.2	98,427.1	67.1
19	Paveroad	2,349.8	1,576.4	97,756.4	66.6
2	Paveroad	589.5	394.5	24,645.7	10.9
20	Paveroad	778.0	520.6	32,525.5	14.3
21	Paveroad	1,010.6	676.3	42,249.9	18.6
22	Paveroad	173.3	116.3	7,210.2	4.9
23	Paveroad	201.5	135.2	8,383.9	5.7
24	Paveroad	24.2	16.2	1,006.1	0.7
25	Paveroad	1,267.3	848.0	52,980.0	23.3
26	Paveroad	60.5	40.6	2,515.2	1.7
27	Paveroad	24.2	16.2	1,006.1	0.7
28	Paveroad	133.0	89.2	5,533.4	3.8
29	Paveroad	741.6	497.5	30,852.7	21.0
3	Paveroad	100.8	67.6	4,192.0	2.9
30	Paveroad	1,483.2	995.0	61,705.5	42.0
31	Paveroad	1,410.7	946.4	58,687.4	40.0
32	Paveroad	165.3	110.9	6,874.8	4.7
33	Paveroad	137.0	91.9	5,701.1	3.9
34	Paveroad	217.7	146.0	9,054.6	6.2
35	Paveroad	338.6	227.1	14,084.9	9.6
36	Paveroad	36.3	24.3	1,509.1	1.0
37	Paveroad	296.8	198.6	12,406.7	5.5
38	Paveroad	173.3	116.3	7,210.2	4.9
39	Paveroad	382.9	256.9	15,929.4	10.9
4	Paveroad	435.3	292.0	18,109.3	12.3
40	Paveroad	28.2	18.9	1,173.8	0.8
41	Paveroad	1,434.9	962.6	59,693.4	40.7
42	Paveroad	790.0	530.0	32,864.9	22.4
43	Paveroad	302.3	202.8	12,575.8	8.6
44	Paveroad	569.5	381.1	23,807.5	10.5
45	Paveroad	344.9	230.8	14,418.6	6.4
46	Paveroad	8.1	5.4	335.4	0.2
47	Paveroad	517.3	346.2	21,628.0	9.5

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48	Paveroad	1,327.4	888.3	55,494.8	24.5
49	Paveroad	894.8	600.3	37,224.6	25.4
5	Paveroad	898.3	601.1	37,555.5	16.6
50	Paveroad	48.4	32.4	2,012.1	1.4
51	Paveroad	197.5	132.5	8,216.2	5.6
52	Paveroad	0.0	0.0	0.0	0.0
53	Paveroad	266.0	178.5	11,066.8	7.5
54	Paveroad	145.1	97.3	6,036.4	4.1
55	Paveroad	298.3	200.1	12,408.2	8.5
56	Paveroad	36.3	24.3	1,509.1	1.0
57	Paveroad	0.0	0.0	0.0	0.0
58	Paveroad	544.1	365.0	22,636.7	15.4
59	Paveroad	0.0	0.0	0.0	0.0
6	Paveroad	16.1	10.8	670.7	0.5
60	Paveroad	786.0	527.3	32,697.2	22.3
61	Paveroad	0.0	0.0	0.0	0.0
62	Paveroad	92.7	62.2	3,856.6	2.6
63	Paveroad	0.0	0.0	0.0	0.0
64	Paveroad	88.7	59.5	3,688.9	2.5
65	Paveroad	137.0	91.9	5,701.1	3.9
66	Paveroad	314.4	210.9	13,078.9	8.9
67	Paveroad	145.1	97.3	6,036.4	4.1
68	Paveroad	72.6	48.7	3,018.2	2.1
69	Paveroad	524.0	351.5	21,798.3	14.9
7	Paveroad	2,326.0	1,556.5	97,241.7	42.9
70	Paveroad	124.9	83.8	5,198.0	3.5
71	Paveroad	340.9	228.1	14,250.9	6.3
72	Paveroad	625.6	418.7	26,154.6	11.5
8	Paveroad	423.2	283.9	17,606.2	12.0
9	Paveroad	76.6	51.4	3,185.9	2.2
	Subtotal	39,224.4	26,286.5	1,635,117.0	950.7
1	StripMining	1,034.0	724.0	21,529.0	11.2
10	StripMining	0.0	0.0	0.0	0.0
11	StripMining	0.0	0.0	0.0	0.0
12	StripMining	792.4	569.3	11,086.6	2.4
13	StripMining	0.0	0.0	0.0	0.0
14	StripMining	599.1	419.5	12,474.6	6.5
15	StripMining	0.0	0.0	0.0	0.0
16	StripMining	0.0	0.0	0.0	0.0
17	StripMining	0.0	0.0	0.0	0.0
18	StripMining	0.0	0.0	0.0	0.0
19	StripMining	0.0	0.0	0.0	0.0
2	StripMining	5,074.5	3,645.8	70,993.3	15.6
20	StripMining	13,314.2	9,566.0	186,272.6	40.9
21	StripMining	20,516.3	14,740.3	287,030.6	63.0
22	StripMining	11,956.5	8,372.2	248,951.7	130.1
23	StripMining	7,757.0	5,431.8	161,513.8	84.4
24	StripMining	307.5	215.4	6,403.6	3.3
25	StripMining	11,487.6	8,253.5	160,716.5	35.3

26	StripMining	7,847.1	5,494.9	163,389.8	85.4
27	StripMining	392.4	274.8	8,170.8	4.3
28	StripMining	8,822.7	6,178.0	183,703.2	96.0
29	StripMining	4,703.0	3,293.2	97,925.2	51.2
3	StripMining	0.0	0.0	0.0	0.0
30	StripMining	5,609.8	3,928.1	116,803.7	61.0
31	StripMining	10.5	7.3	218.4	0.1
32	StripMining	1,023.2	716.5	21,305.5	11.1
33	StripMining	0.0	0.0	0.0	0.0
34	StripMining	63.7	44.6	1,325.4	0.7
35	StripMining	0.0	0.0	0.0	0.0
36	StripMining	0.0	0.0	0.0	0.0
37	StripMining	14,153.7	10,169.1	198,013.6	43.4
38	StripMining	2,221.7	1,555.7	46,260.0	24.2
39	StripMining	418.9	293.3	8,721.9	4.6
4	StripMining	63.7	44.6	1,325.4	0.7
40	StripMining	0.0	0.0	0.0	0.0
41	StripMining	908.8	636.4	18,923.0	9.9
42	StripMining	0.0	0.0	0.0	0.0
43	StripMining	0.0	0.0	0.0	0.0
44	StripMining	0.0	0.0	0.0	0.0
45	StripMining	0.0	0.0	0.0	0.0
46	StripMining	0.0	0.0	0.0	0.0
47	StripMining	0.0	0.0	0.0	0.0
48	StripMining	0.0	0.0	0.0	0.0
49	StripMining	0.0	0.0	0.0	0.0
5	StripMining	402.1	288.9	5,625.5	1.2
50	StripMining	482.5	337.9	10,047.2	5.2
51	StripMining	2,391.2	1,674.4	49,789.3	26.0
52	StripMining	0.0	0.0	0.0	0.0
53	StripMining	493.0	345.2	10,265.6	5.4
54	StripMining	424.1	297.0	8,831.1	4.6
55	StripMining	12,815.3	8,973.7	266,838.4	139.4
56	StripMining	137.8	96.5	2,869.2	1.5
57	StripMining	747.7	523.5	15,567.3	8.1
58	StripMining	18,191.6	12,738.4	378,778.6	197.9
59	StripMining	132.6	92.8	2,760.0	1.4
6	StripMining	0.0	0.0	0.0	0.0
60	StripMining	17,481.2	12,240.9	363,988.4	190.2
61	StripMining	0.0	0.0	0.0	0.0
62	StripMining	0.0	0.0	0.0	0.0
63	StripMining	0.0	0.0	0.0	0.0
64	StripMining	21.2	14.9	441.8	0.2
65	StripMining	0.0	0.0	0.0	0.0
66	StripMining	3,488.8	2,443.0	72,644.2	38.0
67	StripMining	0.0	0.0	0.0	0.0
68	StripMining	5.2	3.7	109.2	0.1
69	StripMining	0.0	0.0	0.0	0.0
7	StripMining	0.0	0.0	0.0	0.0
70	StripMining	0.0	0.0	0.0	0.0

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71	StripMining	491.8	353.3	6,880.3	1.5
72	StripMining	0.0	0.0	0.0	0.0
8	StripMining	0.0	0.0	0.0	0.0
9	StripMining	0.0	0.0	0.0	0.0
	Subtotal	176,784.5	124,998.6	3,228,494.0	1,406.0
1	Underground Mines	0.0	0.0	0.0	0.0
10	Underground Mines	0.0	0.0	0.0	0.0
11	Underground Mines	0.0	0.0	0.0	0.0
12	Underground Mines	0.0	0.0	0.0	0.0
13	Underground Mines	0.0	0.0	0.0	0.0
14	Underground Mines	0.0	0.0	0.0	0.0
15	Underground Mines	0.0	0.0	0.0	0.0
16	Underground Mines	0.0	0.0	0.0	0.0
17	Underground Mines	0.0	0.0	0.0	0.0
18	Underground Mines	0.0	0.0	0.0	0.0
19	Underground Mines	0.0	0.0	0.0	0.0
2	Underground Mines	0.0	0.0	0.0	0.0
20	Underground Mines	0.0	0.0	0.0	0.0
21	Underground Mines	0.0	0.0	0.0	0.0
22	Underground Mines	0.0	0.0	0.0	0.0
23	Underground Mines	0.0	0.0	0.0	0.0
24	Underground Mines	0.0	0.0	0.0	0.0
25	Underground Mines	0.0	0.0	0.0	0.0
26	Underground Mines	0.0	0.0	0.0	0.0
27	Underground Mines	0.0	0.0	0.0	0.0
28	Underground Mines	0.0	0.0	0.0	0.0
29	Underground Mines	0.0	0.0	0.0	0.0
3	Underground Mines	0.0	0.0	0.0	0.0
30	Underground Mines	0.0	0.0	0.0	0.0
31	Underground Mines	0.0	0.0	0.0	0.0

32	Underground Mines	0.0	0.0	0.0	0.0
33	Underground Mines	0.0	0.0	0.0	0.0
34	Underground Mines	0.0	0.0	0.0	0.0
35	Underground Mines	0.0	0.0	0.0	0.0
36	Underground Mines	0.0	0.0	0.0	0.0
37	Underground Mines	0.0	0.0	0.0	0.0
38	Underground Mines	0.0	0.0	0.0	0.0
39	Underground Mines	0.0	0.0	0.0	0.0
4	Underground Mines	0.0	0.0	0.0	0.0
40	Underground Mines	0.0	0.0	0.0	0.0
41	Underground Mines	329.0	232.3	3,433.0	2.7
42	Underground Mines	0.0	0.0	0.0	0.0
43	Underground Mines	0.0	0.0	0.0	0.0
44	Underground Mines	0.0	0.0	0.0	0.0
45	Underground Mines	0.0	0.0	0.0	0.0
46	Underground Mines	0.0	0.0	0.0	0.0
47	Underground Mines	0.0	0.0	0.0	0.0
48	Underground Mines	0.0	0.0	0.0	0.0
49	Underground Mines	0.0	0.0	0.0	0.0
5	Underground Mines	0.0	0.0	0.0	0.0
50	Underground Mines	0.0	0.0	0.0	0.0
51	Underground Mines	0.0	0.0	0.0	0.0
52	Underground Mines	0.0	0.0	0.0	0.0
53	Underground Mines	0.0	0.0	0.0	0.0
54	Underground Mines	0.0	0.0	0.0	0.0
55	Underground Mines	0.0	0.0	0.0	0.0
56	Underground Mines	0.0	0.0	0.0	0.0
57	Underground Mines	0.0	0.0	0.0	0.0
58	Underground Mines	0.0	0.0	0.0	0.0

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59	Underground Mines	0.0	0.0	0.0	0.0
6	Underground Mines	0.0	0.0	0.0	0.0
60	Underground Mines	0.0	0.0	0.0	0.0
61	Underground Mines	0.0	0.0	0.0	0.0
62	Underground Mines	0.0	0.0	0.0	0.0
63	Underground Mines	0.0	0.0	0.0	0.0
64	Underground Mines	0.0	0.0	0.0	0.0
65	Underground Mines	0.0	0.0	0.0	0.0
66	Underground Mines	0.0	0.0	0.0	0.0
67	Underground Mines	0.0	0.0	0.0	0.0
68	Underground Mines	0.0	0.0	0.0	0.0
69	Underground Mines	0.0	0.0	0.0	0.0
7	Underground Mines	0.0	0.0	0.0	0.0
70	Underground Mines	0.0	0.0	0.0	0.0
71	Underground Mines	0.0	0.0	0.0	0.0
72	Underground Mines	0.0	0.0	0.0	0.0
8	Underground Mines	890.4	628.6	9,289.3	7.2
9	Underground Mines	0.0	0.0	0.0	0.0
	Subtotal	1,219.4	860.9	12,722.3	9.8
1	UrbanImpervious	18.5	12.5	1,367.8	1.0
10	UrbanImpervious	2,639.9	1,774.9	202,669.4	98.2
11	UrbanImpervious	482.4	324.3	37,032.5	17.9
12	UrbanImpervious	1,275.6	857.7	97,931.5	47.4
13	UrbanImpervious	1,373.3	927.4	101,442.3	75.7
14	UrbanImpervious	367.7	248.3	27,161.3	20.3
15	UrbanImpervious	150.0	101.3	11,082.8	8.3
16	UrbanImpervious	135.8	91.7	10,031.2	7.5
17	UrbanImpervious	31.4	21.2	2,321.4	1.7
18	UrbanImpervious	260.5	175.9	19,244.3	14.4
19	UrbanImpervious	327.0	220.8	24,156.2	18.0
2	UrbanImpervious	66.3	44.6	5,087.2	2.5
20	UrbanImpervious	60.0	40.4	4,609.2	2.2
21	UrbanImpervious	83.7	56.3	6,427.4	3.1
22	UrbanImpervious	32.6	22.0	2,406.4	1.8
23	UrbanImpervious	0.0	0.0	0.0	0.0
24	UrbanImpervious	3.5	2.3	256.7	0.2

25	UrbanImpervious	125.8	84.6	9,655.8	4.7
26	UrbanImpervious	10.6	7.1	781.9	0.6
27	UrbanImpervious	0.0	0.0	0.0	0.0
28	UrbanImpervious	7.4	5.0	549.7	0.4
29	UrbanImpervious	103.9	70.2	7,673.6	5.7
3	UrbanImpervious	0.0	0.0	0.0	0.0
30	UrbanImpervious	68.8	46.5	5,083.5	3.8
31	UrbanImpervious	121.3	81.9	8,958.0	6.7
32	UrbanImpervious	0.0	0.0	0.0	0.0
33	UrbanImpervious	38.7	26.1	2,859.1	2.1
34	UrbanImpervious	7.0	4.7	513.5	0.4
35	UrbanImpervious	10.6	7.1	781.9	0.6
36	UrbanImpervious	7.0	4.7	513.5	0.4
37	UrbanImpervious	19.9	13.4	1,530.9	0.7
38	UrbanImpervious	14.1	9.5	1,038.6	0.8
39	UrbanImpervious	67.8	45.8	5,008.7	3.7
4	UrbanImpervious	145.6	98.3	10,752.4	8.0
40	UrbanImpervious	7.0	4.7	513.5	0.4
41	UrbanImpervious	173.5	117.2	12,817.8	9.6
42	UrbanImpervious	156.2	105.5	11,534.9	8.6
43	UrbanImpervious	17.5	11.8	1,295.3	1.0
44	UrbanImpervious	62.2	41.8	4,773.3	2.3
45	UrbanImpervious	46.0	30.9	3,528.2	1.7
46	UrbanImpervious	0.0	0.0	0.0	0.0
47	UrbanImpervious	18.9	12.7	1,449.8	0.7
48	UrbanImpervious	86.7	58.3	6,659.3	3.2
49	UrbanImpervious	28.1	19.0	2,077.2	1.6
5	UrbanImpervious	22.6	15.2	1,737.1	0.8
50	UrbanImpervious	14.6	9.8	1,074.8	0.8
51	UrbanImpervious	3.5	2.3	256.7	0.2
52	UrbanImpervious	0.0	0.0	0.0	0.0
53	UrbanImpervious	0.0	0.0	0.0	0.0
54	UrbanImpervious	0.0	0.0	0.0	0.0
55	UrbanImpervious	67.0	45.2	4,947.9	3.7
56	UrbanImpervious	7.0	4.7	513.5	0.4
57	UrbanImpervious	3.5	2.3	256.7	0.2
58	UrbanImpervious	108.2	73.0	7,989.7	6.0
59	UrbanImpervious	0.0	0.0	0.0	0.0
6	UrbanImpervious	5.0	3.3	365.7	0.3
60	UrbanImpervious	24.6	16.6	1,820.5	1.4
61	UrbanImpervious	0.0	0.0	0.0	0.0
62	UrbanImpervious	0.0	0.0	0.0	0.0
63	UrbanImpervious	0.0	0.0	0.0	0.0
64	UrbanImpervious	0.0	0.0	0.0	0.0
65	UrbanImpervious	10.6	7.1	781.9	0.6
66	UrbanImpervious	14.9	10.1	1,100.0	0.8
67	UrbanImpervious	15.0	10.2	1,111.4	0.8
68	UrbanImpervious	0.0	0.0	0.0	0.0
69	UrbanImpervious	59.7	40.3	4,411.1	3.3
7	UrbanImpervious	1,763.5	1,185.7	135,384.1	65.6

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70	UrbanImpervious	0.0	0.0	0.0	0.0
71	UrbanImpervious	22.6	15.2	1,737.1	0.8
72	UrbanImpervious	7.5	5.0	574.7	0.3
8	UrbanImpervious	89.5	60.4	6,608.7	4.9
9	UrbanImpervious	5.5	3.7	403.4	0.3
	Subtotal	10,897.4	7,339.0	824,653.0	479.1
1	UrbanPervious	3.0	2.1	294.8	0.1
10	UrbanPervious	426.2	303.5	24,030.2	1.4
11	UrbanPervious	62.6	44.6	3,530.7	0.2
12	UrbanPervious	161.2	114.8	9,088.1	0.5
13	UrbanPervious	901.0	616.5	87,353.2	23.2
14	UrbanPervious	68.5	46.8	6,636.7	1.8
15	UrbanPervious	27.8	19.0	2,692.5	0.7
16	UrbanPervious	34.3	23.5	3,329.2	0.9
17	UrbanPervious	23.7	16.2	2,294.1	0.6
18	UrbanPervious	46.4	31.7	4,494.8	1.2
19	UrbanPervious	100.0	68.4	9,697.3	2.6
2	UrbanPervious	10.3	7.3	580.3	0.0
20	UrbanPervious	22.4	16.0	1,264.6	0.1
21	UrbanPervious	1.8	1.3	100.4	0.0
22	UrbanPervious	3.8	2.6	365.9	0.1
23	UrbanPervious	0.0	0.0	0.0	0.0
24	UrbanPervious	0.2	0.1	17.6	0.0
25	UrbanPervious	10.6	7.5	596.1	0.0
26	UrbanPervious	0.6	0.4	53.5	0.0
27	UrbanPervious	0.0	0.0	0.0	0.0
28	UrbanPervious	1.4	1.0	138.2	0.0
29	UrbanPervious	48.7	33.3	4,722.5	1.3
3	UrbanPervious	0.0	0.0	0.0	0.0
30	UrbanPervious	17.5	12.0	1,696.8	0.4
31	UrbanPervious	30.1	20.6	2,914.8	0.8
32	UrbanPervious	0.0	0.0	0.0	0.0
33	UrbanPervious	2.0	1.4	195.7	0.1
34	UrbanPervious	0.4	0.2	35.1	0.0
35	UrbanPervious	0.6	0.4	53.5	0.0
36	UrbanPervious	0.4	0.2	35.1	0.0
37	UrbanPervious	1.1	0.8	59.9	0.0
38	UrbanPervious	0.7	0.5	71.1	0.0
39	UrbanPervious	5.6	3.8	543.9	0.1
4	UrbanPervious	163.4	111.8	15,842.7	4.2
40	UrbanPervious	0.4	0.2	35.1	0.0
41	UrbanPervious	34.2	23.4	3,318.7	0.9
42	UrbanPervious	11.3	7.7	1,095.7	0.3
43	UrbanPervious	0.9	0.6	88.6	0.0
44	UrbanPervious	2.2	1.5	121.7	0.0
45	UrbanPervious	3.7	2.6	209.4	0.0
46	UrbanPervious	0.0	0.0	0.0	0.0
47	UrbanPervious	0.3	0.2	18.0	0.0
48	UrbanPervious	16.9	12.0	951.3	0.1

49	UrbanPervious	1.5	1.0	142.1	0.0
5	UrbanPervious	0.4	0.3	21.6	0.0
50	UrbanPervious	1.8	1.2	174.1	0.0
51	UrbanPervious	0.2	0.1	17.6	0.0
52	UrbanPervious	0.0	0.0	0.0	0.0
53	UrbanPervious	0.0	0.0	0.0	0.0
54	UrbanPervious	0.0	0.0	0.0	0.0
55	UrbanPervious	48.6	33.3	4,714.8	1.2
56	UrbanPervious	0.4	0.2	35.1	0.0
57	UrbanPervious	0.2	0.1	17.6	0.0
58	UrbanPervious	54.7	37.5	5,308.0	1.4
59	UrbanPervious	0.0	0.0	0.0	0.0
6	UrbanPervious	10.7	7.3	1,040.1	0.3
60	UrbanPervious	1.3	0.9	124.6	0.0
61	UrbanPervious	0.0	0.0	0.0	0.0
62	UrbanPervious	0.0	0.0	0.0	0.0
63	UrbanPervious	0.0	0.0	0.0	0.0
64	UrbanPervious	0.0	0.0	0.0	0.0
65	UrbanPervious	0.6	0.4	53.5	0.0
66	UrbanPervious	17.6	12.0	1,703.0	0.5
67	UrbanPervious	10.2	7.0	990.5	0.3
68	UrbanPervious	0.0	0.0	0.0	0.0
69	UrbanPervious	3.1	2.1	301.9	0.1
7	UrbanPervious	418.1	297.7	23,569.7	1.4
70	UrbanPervious	0.0	0.0	0.0	0.0
71	UrbanPervious	0.4	0.3	21.6	0.0
72	UrbanPervious	0.1	0.1	7.1	0.0
8	UrbanPervious	61.5	42.1	5,960.7	1.6
9	UrbanPervious	4.5	3.1	434.5	0.1
	Subtotal	2,881.7	2,003.5	233,206.0	48.6
1	Wetlands	0.0	0.0	0.0	0.0
10	Wetlands	0.0	0.0	0.0	0.0
11	Wetlands	0.0	0.0	0.0	0.0
12	Wetlands	0.0	0.0	0.0	0.0
13	Wetlands	0.0	0.0	0.0	0.0
14	Wetlands	118.6	87.7	26,955.1	11.8
15	Wetlands	6.5	4.8	1,485.4	0.7
16	Wetlands	16.7	12.3	3,784.8	1.7
17	Wetlands	0.0	0.0	0.0	0.0
18	Wetlands	0.0	0.0	0.0	0.0
19	Wetlands	0.0	0.0	0.0	0.0
2	Wetlands	0.0	0.0	0.0	0.0
20	Wetlands	0.0	0.0	0.0	0.0
21	Wetlands	0.0	0.0	0.0	0.0
22	Wetlands	0.0	0.0	0.0	0.0
23	Wetlands	0.0	0.0	0.0	0.0
24	Wetlands	0.0	0.0	0.0	0.0
25	Wetlands	0.0	0.0	0.0	0.0
26	Wetlands	0.0	0.0	0.0	0.0
27	Wetlands	0.0	0.0	0.0	0.0

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28	Wetlands	0.0	0.0	0.0	0.0
29	Wetlands	0.0	0.0	0.0	0.0
3	Wetlands	0.0	0.0	0.0	0.0
30	Wetlands	0.0	0.0	0.0	0.0
31	Wetlands	0.0	0.0	0.0	0.0
32	Wetlands	0.0	0.0	0.0	0.0
33	Wetlands	0.0	0.0	0.0	0.0
34	Wetlands	0.0	0.0	0.0	0.0
35	Wetlands	0.0	0.0	0.0	0.0
36	Wetlands	0.0	0.0	0.0	0.0
37	Wetlands	0.0	0.0	0.0	0.0
38	Wetlands	0.0	0.0	0.0	0.0
39	Wetlands	0.0	0.0	0.0	0.0
4	Wetlands	0.0	0.0	0.0	0.0
40	Wetlands	0.0	0.0	0.0	0.0
41	Wetlands	0.0	0.0	0.0	0.0
42	Wetlands	0.0	0.0	0.0	0.0
43	Wetlands	0.0	0.0	0.0	0.0
44	Wetlands	0.0	0.0	0.0	0.0
45	Wetlands	0.0	0.0	0.0	0.0
46	Wetlands	0.0	0.0	0.0	0.0
47	Wetlands	0.0	0.0	0.0	0.0
48	Wetlands	0.0	0.0	0.0	0.0
49	Wetlands	0.0	0.0	0.0	0.0
5	Wetlands	0.0	0.0	0.0	0.0
50	Wetlands	0.0	0.0	0.0	0.0
51	Wetlands	0.0	0.0	0.0	0.0
52	Wetlands	0.0	0.0	0.0	0.0
53	Wetlands	0.0	0.0	0.0	0.0
54	Wetlands	0.0	0.0	0.0	0.0
55	Wetlands	0.0	0.0	0.0	0.0
56	Wetlands	0.0	0.0	0.0	0.0
57	Wetlands	0.0	0.0	0.0	0.0
58	Wetlands	0.0	0.0	0.0	0.0
59	Wetlands	0.0	0.0	0.0	0.0
6	Wetlands	0.0	0.0	0.0	0.0
60	Wetlands	0.0	0.0	0.0	0.0
61	Wetlands	0.0	0.0	0.0	0.0
62	Wetlands	0.0	0.0	0.0	0.0
63	Wetlands	0.0	0.0	0.0	0.0
64	Wetlands	0.0	0.0	0.0	0.0
65	Wetlands	0.0	0.0	0.0	0.0
66	Wetlands	0.0	0.0	0.0	0.0
67	Wetlands	0.0	0.0	0.0	0.0
68	Wetlands	0.0	0.0	0.0	0.0
69	Wetlands	0.0	0.0	0.0	0.0
7	Wetlands	0.0	0.0	0.0	0.0
70	Wetlands	0.0	0.0	0.0	0.0
71	Wetlands	0.0	0.0	0.0	0.0

72	Wetlands	0.0	0.0	0.0	0.0
8	Wetlands	0.0	0.0	0.0	0.0
9	Wetlands	0.0	0.0	0.0	0.0
Subtotal	Wetlands	141.8	104.8	32,225.2	14.1